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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SOME REFORMS NEEDED IN THE TEACHING OF PHYSICS[1]

LAST year's decision of the council of the American Association shows clearly the desirability of distinguishing between the work of the various sections and that of the more technical, scientific societies which meet in conjunction with the association. By leaving the presentation of special papers on research topics to the American Physical Society our section will in future pay more attention than heretofore to the discussion of general topics and by joint sessions with other sections strengthen the, in recent years, somewhat neglected ties between physics and allied sciences. There is an abundance of general subjects from which to choose.

For example, during the past few years a renewed interest has been shown, especially by high school teachers, in the teaching of physics—leading in the course of events to the so-called "new movement among physics teachers," new only in so far as it is an organized effort to improve the teaching of the subject in the high schools.

Your speaker has followed this movement with great interest, hoping that some definite reform might be accomplished by it; but it must be admitted that, as far as actual improvements in those high schools, where such improvements are most needed, are concerned, the progress has been very, very slow. The strongest censure which

[1] Address of the vice-president and chairman of Section B—Physics. American Association for the Advancement of Science, Boston, 1909.

can be made is that, while there is no lack of criticism in a general form, as: "The course is too mathematical," or "The course contains too many topics" no clear-cut, definite proposition for reform has yet been made. For example, we have waited in vain for an answer to the question: "Which mathematical relation should be omitted?" or, "Which topics seem superfluous?" Most of the better high school teachers have not changed their course. Why should they do so? We have statistical data showing that over 90 per cent. of the students in the larger Michigan high schools, after having taken physics, which is a required study, declare that they would elect the subject if allowed free choice. But doubtless statistics could also be produced showing the opposite effect upon students in other schools and under other teachers.

There has been considerable hesitancy on the part of the college professor to interest himself in this question; but within the last year or two a change has taken place, and it is a hopeful sign that section B is to have a discussion on educational problems during this week. Let us hope that some positive results may be reached. The decision as to how physics should be taught rests finally with those men who know the subject, understand the spirit of our science and for this reason are the only judges of its characteristic educational value. Leaving the discussion of the teaching of physics in our high schools to our session on Friday, I wish to speak upon a subject seldom touched upon in our former discussions: "The Teaching of Physics in our Colleges and Universities."

Many of us have heard the amusing remark: "The worst teacher is the college professor," a remark which always meets with the hearty approval of unripe high school teachers and arouses an unfortunate antagonism, instead of leading to a helpful cooperation between college and high school men. No matter how much importance we attribute to the new movement or to such a sweeping statement as the one just mentioned, may not we college professors in the end be held responsible for the conditions in the high schools? Or to be specific: "May not the preparation which we give future teachers be faulty?" and "May not our own teaching be capable of improvement?" I believe both these questions should be answered in the affirmative.

1. My first proposition is then: The system of the teaching of physics in many of our colleges and universities is more adapted to train professional physicists than future high school teachers. I take for granted that the two should receive a different training, a statement with which many of you will doubtless not agree. For my own part, I believe that the ideal high school teacher is one who has passed through a complete and thorough graduate course. However, we are not talking about ideals, but about conditions which actually confront us. At the present time the great majority of our high school teachers do not go beyond graduation, and I would deplore any attempt to crowd so much physics into the undergraduate course, that the physicist whom we may finally turn out lacks the general culture which an undergraduate course should give. We can hardly demand that an undergraduate spend more than from 20 to 24 semester hours in the department of physics, even if he expects to teach the subject in the high school.

In many of our institutions an elementary course is given, requiring the knowledge of very little mathematics. After passing this the student is turned loose on advanced studies, often highly specialized mathematical courses. By the time of graduation he will have lost a general

grasp of the subject which he might have had before, but probably never acquired.

We should emphasize more problem work in connection with the elementary course. An utter helplessness of many higher classmen in attacking elementary problems is not unusual. The laboratory work given with the elementary course is frequently quite insufficient, and a somewhat advanced course, not in special lines, but covering the whole field, will do an untold amount of good. Finally there should be a general review of the whole subject from a higher point of view than is possible in the elementary course. Calculus might be a required study for this. At this point subjects might be taken up which have been omitted in the first course, the treatment could be more thorough and more exact. I believe that the introduction of such an advanced course would also have a good influence upon the first course. Now we feel too much under an obligation to present as large an amount of information as can be crowded into two semesters. If we know that those who are interested in our science can obtain a knowledge of the less common phenomena later on, these might be omitted at first and the elementary course could be made more thorough in what it teaches. Several text-books on university physics contain so much material and a good deal of it presented from such an advanced point of view, that they can not be covered the first year. The more difficult topics might well be reserved for such a course as I propose. Finally, every teacher of physics should be acquainted with the history of his science. The gross ignorance among some physics teachers of the development of physical theories and of the work of the intellectual giants, to whom mankind is indebted for its present civilization, is appalling.

A course of study, as outlined, would not require more than 24 semester hours. I might add that, where time allows, I would advise future physics teachers to take also a course in meteorology, a short course in dynamo-electric machinery and an elementary course in instrument-making, all of which might properly be given in the physics department. It is my firm belief that such a graded course will produce teachers to whom we may leave without hesitancy the question as to how physics should be taught in the high school. I have nothing to say about those people whom an incompetent school board appoints, though they had never more than a one-year's elementary training. We university teachers can certainly not be held responsible for their failure. What a pity that we can not prevent such men and women from experimenting upon our children.

It is a hopeful sign that from year to year a larger number of students stay with us after graduation or return during summer school to pursue graduate studies. It shows a slowly growing recognition of the fact that teaching is a profession and that professional knowledge in the chosen line of work is necessary even for high school teachers. Such knowledge can only be acquired by graduate work in this line, *i. e.*, in our case, in physics. An undergraduate course, as outlined above, is certainly not antagonistic to this spirit; yes, may it not raise the standard of our graduate work?

I am fully aware of an objection to my scheme and appreciate its force. You may ask: "Do you wish to prevent the professor in the small college, where the main object is to train teachers, from giving any graduate work?" I must admit, though very reluctantly, that such is the case, provided that the college in question is unable to furnish a sufficiently large instructional staff. If it is a question between one or two graduate courses and a

general review course, I believe the latter should be given. While it may be more interesting and profitable for the professor to teach the advanced subjects, he should subordinate his personal wishes to the efficiency of the college. If he be fortunate enough to discover an exceptional man, is it not best for the latter to go to an institution affording larger facilities for his future work, to an institution where close contact with a number of investigators will stimulate and inspire him? Such a student will always remain loyal to his old college professor and be proud of being a graduate of an institution which has given him a thorough fundamental training.

2. As was suggested in the earlier part of the paper, not alone the college curriculum of the future high school teacher is being criticized, but also our teaching. We must admit that there is and always will be room for reform. The best we can do is to apply remedies after we have been shown clearly just where the trouble lies. In education we should not apply patent medicine, invented to cure general debility. Therefore we will not talk about methods. It would be an unfortunate condition, ending in stagnation, were all university professors forced to teach according to certain pedagogical rules which suppress individuality and kill spontaneous enthusiasm.

I shall be specific and state my second proposition thus: "We are far from being unanimous in the use of certain terms and frequently employ the same term to designate two entirely different physical quantities." This means that we do not pay enough attention to the very things which make physics so valuable as a training of the mind, namely, clearness of thinking and accuracy of expression.

Let me cite the most flagrant cases:

a. What is pressure? In every-day usage it is a force, pure and simple, as illustrated by the classic problem: How large a pressure is exerted upon a vertical wall by a beam leaning against it? Leaving this interpretation entirely out of consideration, is pressure the force, acting upon unit area, or, the force per unit area, *i. e.,* a force divided by an area? In other words: Has pressure the dimensions of a force or not? Both definitions are doubtless taught, but if we assume the former to be correct, then in our formula

$$F = PA$$

A does not represent an area, but the *number* of units of area upon which the force acts. Of course I assume that P stands for pressure.

But if we do this, we get into trouble when we discuss the work done upon or by a gas. For in the equation

$$W = PV$$

the V would no longer represent a volume, but a length. In fact, as soon as we speak of the action of a gas, we discard the force and substitute for it the abstract concept of the proportionality factor P between force and area. This abstract idea, which most of us call pressure, is nevertheless a real physical quantity.

I believe the greatest difficulty to the beginner in physics arises at the very moment when he is confronted with such an abstract physical quantity, *e. g.,* acceleration. He feels suddenly the solid ground slipping away from under his feet and regains confidence only after he has manipulated this quantity again and again in the solution of problems. So it is with pressure; we can not blame the student for trying to hold on to his old friend, the force, as long as he possibly can.

Clifford says: "When that which we do not know how to deal with is described as made up of things we do know how to deal with, we have that sense of increased power which is the basis of all higher

pleasures." We should keep this always in mind in the presentation of our subject, but should not go so far in our wish to arouse this higher pleasure in the student as to make incorrect statements as the one that the pressure coefficient P is a force, and the other quantity A in our first equation an area. Let us be consistent and use the term "pressure" only for one physical quantity, and not for two or even three. In modern education we find too much a tendency to introduce kindergarten methods in the high schools; keep them out of the college.

b. In surface-tension phenomena we have a very similar case, since the force is expressed here by the equation

$$F = Tl.$$

The capillary constant T is usually called "surface tension," but we may read in the same book which gives this definition, that the weight of a liquid is balanced by the surface tension. The latter statement, though consistent with ordinary usage, does not agree with the former definition. All the preceding arguments in favor of accuracy and uniformity in our teaching apply in this case.

It is true, it is a hard task to teach students a new meaning of a word which they have been in the habit of using in a different, or at least in a much broader sense. But are we not successful in making them distinguish between mass and weight, though the same difficulty arises in this case? It is well known that the importance of the law of conservation of energy was not fully appreciated, until the new term "energy" with its definite present physical meaning was introduced and we stopped talking about the conservation of force.

c. In the chapter on Heat we find several inconsistencies. Every physicist knows perfectly well that the term "absolute temperature" refers to temperature measured on the thermodynamic scale. Nevertheless, we call the zero of the constant volume hydrogen thermometer the absolute zero and we call temperatures, measured from this point and by this thermometer, absolute temperatures. We even refer to any gas thermometer, no matter whether of constant volume or constant pressure, in defining absolute temperature. There seems to be no other remedy but to invent a new name, a tempting task for a philologically inclined physicist. Do not let us make light of our trouble because these different temperature scales agree so very closely. They are different. A man has not discovered the north pole even if he came within a few miles of it.

d. Another example occurs in the common expression of quantity of heat as

$$H = cM(t_2 - t_1).$$

The factor c is usually called "specific heat." It is really the "heat capacity of the substance" in question and is taken as unity for water under standard conditions. But it is not a pure number. It has definite dimensions, while "specific heat," defined as the ratio of the heat capacity of the substance to that of water, *is* a pure number; in other words, the relation between these two thermal quantities is exactly similar to that between density and specific gravity. We distinguish very carefully between the latter two, even where the numerical value would be the same.

This numerical equality has done more than anything else to befog our minds about the true nature of a physical quantity. Next in importance comes our inheritance of terms from old, long discarded theories. Think of such terms as "specific heat" which is not heat at all, or "electromotive force" which is no

force. A discussion of all misfitting names would, however, lead us too far from the subject under consideration.

e. Though I do not wish to tire you by an enumeration of all examples of inconsistency in our teaching, I can not pass by in silence a case where our lack of accuracy introduces the most serious difficulties. It is the indiscriminate use of "lines of force," not alone for "lines of intensity," but also for "lines of induction." These two are very different things, as well in electrostatics as in magnetism, and neither the intensity nor induction is a force.

Let us consider a magnet and the field surrounding it. According to the old theory of action at a distance there is no magnetic disturbance anywhere in the space about the magnet, until we introduce a magnetic pole. Then, it is true, we have a force between magnet and pole. But this theory has long been overthrown. We know now that at every point of a magnetic field there exists a certain disturbance, call it a stress, if you please, whose magnitude and direction are given by the intensity of the field at that point. Moreover, the intensity of the magnetic field has nothing to do with a force, except that we may *measure* it by the force acting on pole strength m according to the equation, defining intensity H

$$F = Hm.$$

It is usually stated that the lines of force show the direction of the intensity, and their number through unit area, drawn at right angles to the direction, represents the magnitude of the intensity.

The use of a misleading name is not my main objection. The trouble begins at this point. After having used lines of force as synonymous with lines of intensity, it is serenely asserted that the cutting of lines of force produces an induced electromotive force in a conductor. You know that the magnitude of this electromotive force does not depend upon the intensity, but upon the rate with which the lines of induction are cut.

Only very few text-books give the correct expression for the induced electromotive force as

$$E = Blv.$$

To write H instead of B in this formula is radically wrong. The *numerical* value of E will be correct, provided the medium is air. The dimensional formulæ for the left and right hand sides of the equation balance only if we use B. Every experiment in electromagnetic induction is an example of the correctness of this statement. We all teach that the intensity of the field is analogous to a stress, the induction to a strain in an elastic medium, both being connected by the equation

$$B = \mu H.$$

No one would tolerate such a confusion of stress and strain in mechanics.

The historical development of lines of force is very interesting and explains to a certain extent the origin of our troubles. Faraday introduced the lines of force, but not in the sense of lines of intensity. Many quotations from his writings might be given, all showing that he meant by lines of force what I have called lines of induction. For example he says:[1]

> I have not referred in the foregoing considerations to the view I have recently supported by experimental evidence that the lines of force, considered simply as representants of the magnetic power, are closed curves, passing in one part of their course through the magnet and in the other part through the space about it. *These lines are identical in their nature, qualities and amount, both within the magnet and without.*

It is true, Faraday also speaks of lines in connection with field intensity, but here he uses various terms. Thus he writes:[2]

[1] Faraday, "Researches," Vol. III., p. 417.

[2] "Researches," Vol. I., p. 411.

I have used the phrases *lines of inductive force* and *curved lines* of force in a general sense only, just as we speak of lines of magnetic force.

He does not represent field intensity by lines.

Maxwell, however, changed the meaning by calling Faraday's lines of force lines of induction and using the term lines of force for lines of intensity only.

And we? We use the words sometimes in Faraday's sense, sometimes in Maxwell's sense. We introduce them when speaking of field intensity and later on make the glaring mistake of asserting that the induced electromotive force is measured by the cutting of lines of force. The American Institute of Electrical Engineers has proposed to call the unit of magnetic intensity the "gauss"; it seems to be a general understanding, judging from papers appearing on magnetic subjects, that it is also the unit of induction. Personally I prefer to discard the troublesome term altogether, but it may be that it has become so familiar to the scientist and is so generally used in engineering practise, though usually there in the meaning of lines of induction, that it is too late to abolish it altogether. If we must keep the lines of force in our text-books, let us use them in one sense only. We should certainly stop confusing our students about the real nature of these two totally different quantities.[3]

I hope to have proven that we lack in the presentation of several topics that accuracy of expression of which in general the physicist can be justly so proud, and that greater uniformity in the use of certain terms is very desirable. Our ideas as to the fitness of proposed names for the quantities in question as well as to the choice of definitions, may be widely different. Your speaker clearly realizes that there is ample room for discussion and that the sporadic attempt of a single scientist to correct the apparent faults in our teaching can not better the conditions appreciably.

[3] See also a paper by Professor Patterson, "Michigan Technic," 20, No. 2, p. 35, 1907.

Reforms of a lasting nature can be accomplished and the desired result reached in shortest time, only, if definite propositions be made by a committee consisting of a number of representative physicists. With their influence behind a reform movement of this kind we shall soon reach practical unanimity.

In conclusion, let me assure you from my own experience that it is not an extremely difficult matter to teach the student to make these fine distinctions between different physical quantities. It is true, it requires some deep and accurate thinking; but the result has always been that in the end the subject has become clearer to the student and, as I have been assured, even more interesting.

K. E. GUTHE

THE EVOLUTION OF INTELLIGENCE AND ITS ORGANS[1]

WE recognize two very distinct types of physiological functions: (1) activities concerned with the inner working of the bodily mechanism—nutrition, internal regulation, etc.—and called vegetative or visceral functions; (2) activities concerned with the adjustments of the body to outside, or environmental influences. These we call somatic functions.

These reaction types are, of course, always intimately related and interdependent; nevertheless, as we ascend the scale of animal life the history of the evolution of both structure and function shows a progressive elaboration of each of these

[1] Address of the vice-president and chairman of Section F—Zoology. American Association for the Advancement of Science, Boston, 1909.

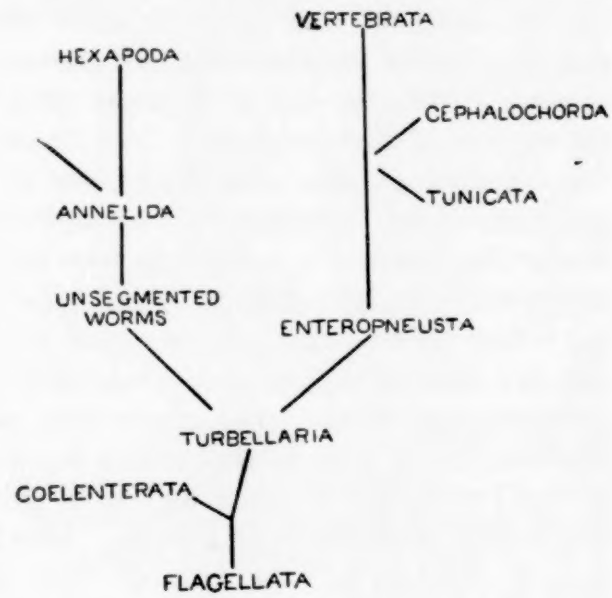
two functional systems and differentiation from the other, so that in higher vertebrates the distinction between them may be said to be fundamental both to anatomy and to physiology.

As children we probably considered the chief distinction between plants and animals to be the ability of the latter to move freely about; but one of the first lessons in our elementary biology was the correction of this notion by the study of sedentary animals and locomotor plants. Nevertheless, I fancy that in the broad view the childish idea has the root of the matter in it. The plants and sedentary animals may have their vegetative functions of internal adjustment never so highly specialized and yet remain relatively low in the biological scale because their relations with the environment are necessarily limited to the small circle within which they first take root, whereas the power of locomotion carries with it, at least potentially, the ability to choose between many more environmental factors. It is only the free-moving animals that have anything to gain by looking ahead in the world, and here only do we find well-developed distance receptors, *i. e.*, sense organs adapted to receive impressions from objects remote from contact with the body. And the distance receptors, as we shall see, have dominated and set the direction of the evolution of the nervous system in vertebrates.

Thus arose the animal head, with its three important functions of feeding, breathing and the recognition of mates and enemies. Parker has recently reviewed[2] in an illuminating way the earlier stages in the differentiation of the nervous system and I shall not attempt to go over this ground again, but will take a bilaterally symmetrical segmented animal with a differentiated head end as the point of departure in an examination of the phylogenetic history of behavior types.

[2] Parker, G. H., *Popular Science Monthly*, 1909.

On anatomical and zoological grounds zoologists are in the habit of subdividing the animal kingdom in the way roughly suggested by the accompanying scheme. Most of the important groups are naturally arranged in two great phyla which have apparently been quite distinct as far down as the flat worms. One of these, which we may call the articulate phylum, includes



the segmented worms, crustaceans, spiders and insects; the other phylum, after passing through a series of obscure invertebrate stages, largely at the present time extinct, culminates in the true vertebrates. It may be termed briefly the vertebrate phylum, and all of its members, from the lowest to the highest, are sharply distinguished from those of the articulate phylum by several characteristics, among which is the development of mesodermal gut pouches. All forms above the Enteropneusta have gill clefts, either embryonic or adult, which likewise develop as gut pouches and a dorsal tubular nervous system, which is derived from the mid-dorsal ectoderm and is separated from the gut by a supporting notochord. The articulates, on the other

hand, have a ladder-like nervous system ventrally of the gut and of totally different origin.

These are illustrations of the nature of the data on the basis of which zoologists are in quite general agreement in recognizing the wide divergence of these two great phyla of metazoa.

Now, students of animal behavior have recognized also two fundamental behavior types among the higher animals. This is clearly stated by Yerkes when he points out[3] that the animal kingdom presents divergent lines in the development of action types.

Certain animals are markedly plastic or voluntary in their behavior, others are as markedly fixed or instinctive. In the primates plasticity has reached its highest known stage of development; in the insects fixity has triumphed, instinctive action is predominant. The ant has apparently sacrificed adaptability to the development of ability to react quickly, accurately and uniformly in a certain way. Roughly, animals might be separated into two classes: those which are in high degree capable of immediate adaptation to their conditions, and those which are apparently automatic since they depend upon instinctive tendencies to action instead of upon rapid adaptation.

If time permitted us to develop this conception, many striking illustrations might be cited of the predominance of now one, now the other, of these action types in different animals. The most striking feature of such an examination is the discovery that, while the generalized members of both of the zoologists' phyla exhibit an extreme development of neither action type, those forms which are structurally highly specialized generally have one or the other action type also highly developed; and in these cases an arrangement of animals according to their type of behavior follows closely the diphyletic arrangement previously elaborated on purely structural grounds. The anatomical basis of this harmony is readily apparent when the nervous systems of the two phyla are compared.

[3] *Journal of Comparative Neurology and Psychology*, Vol. 15, 1905, p. 137.

The central nervous system of the articulates is fundamentally a segmented ladder-like chain of nerve tissue with special ganglionic enlargements in the head related to the leading sense organs. It is dominated by the general body metamerism and the segmental reflex arcs are kept relatively distinct by the anatomical configuration. Some of the compound and chain reflexes are very complex; yet they tend to follow the appropriate stimuli with a mechanical precision which is simply an expression of the accurate working of a pre-formed mechanism. Since this is an inherited mechanism, all members of the species exhibit similar reactions and these do not require experience for their performance. This is instinct.

On the other hand, the vertebrate nervous system is fundamentally an epithelial tube, only imperfectly segmented, which contains not only direct reflex mechanisms of the articulate type, but also a massive continuous column of nerve cells and connecting fibers, the reticular formation, which is a diffuse correlation center related to all of the reflex arcs. In the head there are special enlargements derived from this (incompletely) segmented reticular formation, which make up the greater part of the brain in a higher vertebrate. These are the special correlation centers or the suprasegmental apparatuses of Adolf Meyer's terminology.

The entire vertebrate plan of nervous system is totally different from that of any member of the articulate series and, while adapted to perform stereotyped reflexes and instinctive modes of behavior, is also capable of wholly different types of reac-

tion based on the functional plasticity of the reticular formation and its derivatives. There is, of course, some measure of plasticity in the behavior of arthropods, *e. g.*, some ability to learn by experience, and they possess some tissue corresponding to the reticular formation; but in the broad view the distinctions just drawn are characteristic of the two phyla.

Without going into further detail, we may, then, generalize that the higher insects mark the culmination of the stereotyped or instinctive type of behavior, while the primates represent the culmination of the plastic, docile or rational type, and that the structural basis of this plasticity of the vertebrates is found in the relation of the reticular formation of their nervous systems to the other elements of the neural tube and especially in the suprasegmental correlation centers derived therefrom. The lower vertebrates are far inferior to the higher insects in many respects—often perhaps in the very ability to profit by experience of which we have been speaking; but their physical organization is such as to favor future differentiation in this direction, while that of the insects is such as to forbid it. Thus it appears probable that the dominance of the vertebrate type was foreshadowed far back among the ancestral crawling things in which no truly vertebrate character was manifest, foreshadowed merely by a structural type with different latent potencies.

The arthropod type of organization and action system is rigidly stereotyped in the race as well as in the individual; *i. e.*, it tends to be transmitted without modification from generation to generation. Its pattern can be changed only by natural selection or some other agency which can act through heredity. The more plastic vertebrate type is not fixed completely at birth by heredity, but its precise form is more largely acquired as individual experience advances. As intelligence plays a progressively greater part in the behavior, infancy will be prolonged to afford the necessary opportunity for the plastic nervous system to be shaped in adaptation to the individual needs of the animal. The instruments of racial progress here are not merely natural selection acting through heredity, but also docility, social heredity and organic selection, acting largely through intelligent adaptation.

In the vertebrates the amount of preformed or inborn organization, both of structure and of function, is in general greater than in arthropods; but there is superposed upon this rigidly predetermined tissue in higher vertebrates the unspecialized embryonic correlation tissue, the details of whose organization are not laid down in the hereditary pattern, but are individually acquired during development. The ultimate pattern which will be assumed by this plastic tissue is largely shaped by the exigencies of function during the period of its immaturity and this in turn rests upon the nature of the environmental factors. In short, the educational period is limited to the age during which the epigenetic tissue, *i. e.*, the correlation centers whose form is not predetermined in heredity, retains its plasticity under environmental influence.

Ultimately even the cerebral cortex matures and loses its power of reacting except in fixed modes. Its unspecialized tissue —originally a diffuse and equipotential nervous meshwork—becomes differentiated along definite lines and the fundamental pattern becomes more or less rigid. The docile period is past and, though the man may continue to improve in the technique of his performance, he can no longer do creative work. He is apt to say, "The dog is too old to learn new tricks." Whether

this process occurs at the age of twenty or eighty years, it is the beginning of senility. And, alas, that this coagulation of the mental powers often takes place so early! Many a boy's brains are curdled and squeezed into traditional artificial molds before he leaves the grades at school. His education is complete and senile sclerosis of the mind has begun by the time he has learned his trade. For how many such disasters our brick-yard methods in the public schools are responsible is a question of lively interest.

We who seek to enter into the kingdom of knowledge and to continue to advance therein must not only become as little children, but we must learn to *continue so.* The problem of scientific pedagogy, then, is essentially this: to prolong the plasticity of childhood, or otherwise expressed, to reduce the interval between the first childhood and the second childhood to as small dimensions as possible.

The docile or educational period of a mammal is largely devoted to the progressive mechanization of the in-born plastic tissue of the higher correlation centers, *i. e.,* to habit formation, or otherwise expressed to the elaboration of acquired automatisms and reflexes of the type commonly referred to as lapsed intelligence. Much confusion has arisen from the failure to distinguish these individually acquired automatisms from those performed in the hereditary pattern, *i. e.,* lapsed intelligence from true instinct.

Now to return from this digression, let us consider some data bearing on the phylogeny of the nervous functions in vertebrates. We have commented upon the fact that the tubular form of the vertebrate nervous system presents mechanical advantages over the ladder-like form of the articulates for the development of correlation tissue and that the parent type of this tissue is found in the central gray and reticular formation which borders the gray matter in the spinal cord.

The nervous mechanism of the remarkable adaptiveness, the apparent purposefulness, of the spinal cord reflexes has been lucidly explained by Sherrington in his Silliman lectures, where he shows that one of the chief functions of the correlation cells of the gray matter (cells of the reticular formation type) is the elaboration of a single final common path adapted to serve, as occasion may require, a large and variable number of receptors and afferent paths. Although this apparatus reacts largely in a fixed and invariable mode depending on the internal connections of the neurones of which it is composed, nevertheless it possesses a certain amount of flexibility growing out of a variable internal resistance at the synapses, or points of physiological union of one nerve cell with another, and particularly the modification of this resistance by practise or habit. This modifiability is not *per se* evidence of anything psychic; for we find it in unicellular animals and plants with no nervous system and even in many dead mechanisms; yet this feature is the point of departure for those higher types of correlation centers which serve as the organs of mind *par excellence.*

In the head end of the neural tube there is an obvious tendency for the peripheral nerves serving a single function to converge just before or just after they enter the brain so as to reach a single primary center. This concentration of functional systems is obviously advantageous in facilitating the distribution of afferent impulses to their proper motor organs, especially the total reactions so characteristic of vertebrate life as distinguished from the segmental reflexes characteristic of worms and insects. The enlargement of these primary

sensory centers, which sometimes attain to enormous size, does not imply any more highly developed psychic powers than those of allied species with smaller brains; but rather a higher elaboration of certain reflex activities only.

The same is in large measure true of certain suprasegmental or secondary correlation centers. Thus, each one of the organs of higher sense discharges its afferent impulses into a massive primary receptive center and this in turn transmits it to correlation centers of the second, third and higher orders, where these nerve impulses are brought into relation with those from other sense organs and with the appropriate efferent pathways to the muscles or other organs of response. The correlation centers of this sort, which make up a large part of the thalamus and midbrain, are derivatives of the formatio reticularis tissue and are functionally of the same type. They permit of wonderfully complex discriminative reactions and are more readily modifiable by experience than are those of the spinal cord and medulla oblongata.

There is another type of highly developed correlation center whose psychic value is still less than the sensori-motor stations of which we have just been speaking. I refer to the central mechanism of what Sherrington calls the proprioceptive system.[4] Of this the cerebellum is the most important example. The chief function of this system being the coordination and regulation of the skeletal musculature and other organs of somatic response (as distinguished from the interoceptive or visceral effectors), it is naturally purely reflex and its function is disturbed rather than facilitated by voluntary interference.

The correlation centers of the cerebral hemispheres occupy a unique position. Their interpretation is possible only in the light of their origin in the lower groups of vertebrates. Numberless researches by our most able anatomists and physiologists have accumulated a vast wealth of data on this subject, which have, however, stubbornly resisted correlation and interpretation. Our debt to the generalizations and luminous terminology of Sherrington appears on almost every page of this address. Let us begin our inquiry into the origin of cortical function with an examination of a typical feeding reaction.

The primitive feeding reactions are very simple reflexes, but even in the lowest animals they are easily modifiable, as Jennings has shown for protozoa and Parker for sea anemones. Predaceous species among the lowly vertebrates commonly hesitate long before they strike, but once the action is initiated it follows to completion in a very precise and invariable fashion. The pike or the frog will watch the moving prey long before the forward leap is made to seize it; but when once taken it will generally be swallowed at once whether it be a living fly or an artificial one.

Sherrington in discussing this reaction divides it into an anticipatory phase—fixation, coordination of somatic movement for the leap and seizure—and a consummatory reaction of mastication, swallowing, etc. It is the latter alone which gives satisfaction and in the interval which elapses between the beginning of the anticipatory reaction and the consummatory reaction we shall find the key to the problem of cortical function.

The whole feeding reaction in the lowest animals is so far as we can judge a blind reflex; the consummatory phase is largely so even in the highest animals, for once a morsel is in the mouth the processes of mastication and deglutition go on quite automatically.

[4] On the relation of this system to the exteroceptive, see my article on the "Morphological Subdivision of the Brain," *Journal of Comparative Neurology and Psychology*, Vol. 18, 1908, p. 395.

With the anticipatory phase, however, the case is quite different. The more complex the feeding act becomes, the more prolonged and difficult is this phase of the process. In the case of carnivorous vertebrates the prey must be recognized at a distance and carefully stalked and attacked from the most advantageous side, and all of these details will vary with each trial. No combination of simple reflex arcs can be laid down in advance within the nervous system which will be adequate to meet the infinite variations of these problems.

We may hypothecate the course of the evolution of this reaction as follows: In the lower animals, as in the spinal cords of the higher ones, the whole formatio reticularis, or correlation tissue, is relatively unspecialized and receives all kinds of afferent impulses from the primary sensory centers; these in turn it delivers over to the final common efferent pathways. There is thus a constant collateral avenue of nervous discharge through the reticular formation parallel with that in the primary reflex arcs and reinforcing, inhibiting or otherwise modifying these primary simple reflexes.

The character of the efferent discharge from this reticular formation will depend upon the sources and strength of the afferent impulses, the fluctuating internal resistance of the chains of neurones of which it is composed and other variable factors, some of which, like the resistance at the neurone thresholds, may be modified, as already pointed out, by repetition of function (habit formation).

The suprasegmental correlation centers present essentially the same dynamic aspect, but with the afferent pathways more sharply defined and limited and the whole more perfectly adapted to effect definite types of more complex correlation. Thus, the thalamus becomes a great center for the correlation of somatic reflexes and the hypothalamus for visceral and olfactory reflexes. Accordingly, all of the lower primary correlation centers send strong secondary tracts upward into the diencephalon.

Now to return to the feeding activities, so far as these are contact reactions, such as nosing about in the mud for food, the interval between the anticipatory and consummatory phases is not necessarily long and a very simple reflex mechanism is adequate to distinguish between food and other objects.

But in the more complex cases the interval between the anticipatory and consummatory phases is occupied by the discharge into the higher correlation centers of a series of momentarily changing stimuli from the distance receptors, and the later acts of this phase will be the resultants of all of these influences plus the effects in the centers themselves of vestiges of similar reactions in the past. The whole system is in a state of neural tension which varies constantly as new impulses from the periphery reverberate through its substance. The high neural resistance of this complex tissue raises the threshold of discharge from it so that a certain summation of stimuli takes place before the tension is relieved by a discharge of the neural energy into the lower mechanism of the consummatory reaction, which is already so adjusted as to perform its functions when once actuated more or less mechanically and therefore without the development of such internal resistance as characterizes the anticipatory mechanism.

In the storm and stress of this interval just preceding the consummatory reaction the higher mental faculties are born.

The stream of nervous influences pouring into the higher correlation centers from

the peripheral sense organs contains many elements of no significance to the immediate capture of the quarry. These stimuli the animal learns to ignore, perhaps in the first instance unconsciously, by an application of the biological law of habit; for those reflex arcs which have adaptive value in this particular situation will lead at once to the desired consummatory reaction, leave their permanent vestiges in the nervous system and so be more easily repeated, while the irrelevant stimuli do not lead to a relief of the tension, come to nothing and leave no such vestiges. Upon later repetition of the series, the adaptive stimuli find a more open path through the nervous system than the non-adaptive, and accordingly they from the start tend to set the direction of the nervous discharge through the correlation centers, and during this process the sense organs are reflexly adjusted to the sources of these relevant stimuli to the exclusion of the irrelevant. This is the origin of attention.

The analysis of other types of distance reactions, such as avoidance of enemies, search for mates, etc., would show for them a similar significance for psychogenesis. The important point is that these complex forms of distance reaction demand for their highest efficiency greater flexibility and modifiability of response than do the visceral and contact reactions. Here only is a high degree of intelligence necessary. The cortex cerebri dominates cerebral architecture only in mammals where complex anticipatory reactions dominate the behavior, and foresight, literal and figurative, plays the leading rôle.

The cerebral cortex is a correlation center of a higher order, *i. e.,* farther removed from the primary sensori-motor reflex arcs, than those of the brain stem. It is not different in kind from those centers, but only in the extent of its removal physiologically from the primary centers and the nature and complexity of the associational connections within it. In the lower vertebrates the steps by which it has been gradually lifted above the lower correlation centers can now be traced with a considerable degree of precision. Some of this evidence will be reviewed in the symposium on comparative neurology to be held to-morrow in the meeting of the Association of Anatomists. We have time here merely to state in brief summary a few salient features.

We owe to the genius of Edinger the suggestion that the earliest stages in the origin of the peculiarities of the cerebral hemispheres must be sought in a study of the character of the reflexes connected with the nose and lips, particularly the feeding reactions. These have been termed collectively the "oral sense" (Edinger) or "*Schnüffelsinn*" (Kappers) and may perhaps best be called the muzzle reflexes.

In lower vertebrates the sense organs of the nose are probably the most important receptors in the muzzle reflex complex, and these are distance receptors and not contact receptors. Accordingly, the cerebral hemispheres were built up on the basis of the olfactory correlation centers, or rhinencephalon. In fishes, long before we find a true cerebral cortex, ascending tracts pass from the visceral sensory centers of the hypothalamus (probably mainly gustatory in function) and from the somatic centers of the thalamus and midbrain (mainly tactile in function) to enter the large forebrain correlation centers related to the olfactory apparatus. The association of these sensory elements and their return motor tracts produces the so-called corpus striatum of fishes, an apparatus which is probably largely concerned with reflexes of the nose, lips and mouth.

In Amphibia important optic projection

fibers are added, passing from the external geniculate body of the thalamus to the hemispheres, and also acoustic fibers from the inferior colliculus of the midbrain. Though there is no true cerebral cortex here, the tissue from which it is to arise in reptiles can be definitely identified and this tissue is in the frog clearly divided into a medial part, serving primarily the correlation of olfactory and visceral reflexes, and a lateral part, serving primarily the correlation of olfactory and somatic reflexes. The former gives rise in higher animals to the hippocampus, the latter to the pyriform lobe (uncus), while the rest of the cortex, or neopallium, is in these animals differentiated dorsally between these two masses and serves chiefly for the correlation of non-olfactory reactions.

The two parts of the pallium which we call archipallium and neopallium (*i. e.*, olfactory and non-olfactory cortex) are not of different age, as the names imply. They probably both arose at the same time to serve the delicate discriminative reactions of the muzzle reflexes. Their precursors are found in fishes and amphibians, where their cells are mingled in an undifferentiated tissue which has been called by some authors the epistriatum. They finally (in reptiles) become separated and within each division in mammals subordinate "areas" with more or less characteristic connections are differentiated. The incompleteness of this differentiation is responsible for much of the controversy which has waged regarding the presence and significance of localizable cortical areas.

No cortical area can properly be described as the exclusive center of a particular function. In higher mammals it is true that the several final common paths for particular effectors leave more or less clearly defined areas of cortex and that the several kinds of sensory projection fibers terminate in other more or less definite areas. But these so-called sensory and motor areas are in no proper sense centers for the performance of definite functions. Such a "center" is merely a nodal point in an exceedingly complex system of cells and fibers which must act as a whole in order to perform any function whatsoever. Their relation to cerebral functions is analogous to that of the railway stations of a big city to traffic, each drawing from the whole city its appropriate share of passengers and freight, and their great clinical value grows out of just this segregation of fibers of like functional systems in a narrow space, and not to any mysterious power of generating psychic or any other special forces of their own.

The essence of cortical function is correlation and a cortical center for the performance of a particular function is a physiological absurdity, save in the restricted sense described above, as a nodal point in a very complex system of associated conducting paths. Those reflexes whose simple functions can be localized in a single center have their mechanism abundantly provided for in the brain stem.

In the broad view we may say that intelligence is a function of the cerebral cortex, but only in the sense that here are found the most complex correlations in the chain of vital response whose initial phase is to be sought in the environment which supplies the stimulus and whose final phase is also found in the changes wrought in the environment by the bodily reaction. A similar function is performed in a less perfect way in lower animals which lack the cerebral cortex, and doubtless even in man the subcortical nervous apparatus still plays an important part in all conscious processes.

The resting brain is probably normally during life in a state of neural tension in more or less stable equilibrium. An effective stimulus disturbs this equilibrium and the precise effect will depend upon variable synaptic resistance or neurone thresholds which change with different functional states of the organism as a whole and of the brain in particular. If this activity involves the cerebral cortex of a human brain, it may be a conscious activity, the kind of consciousness depending on the kind of discharge. But the consciousness must not be thought of as localized in any cortical area.

The discharge in question may reverberate to the extreme limits of the nervous system and the peripheral activities may be as essential in determining the conscious content as the cortical. Indeed, we have considerable evidence that many of our conscious acts take their most distinctive psychic qualities from the "back stroke," or reverberation of a neural discharge from the periphery back to the cortex.

Thus far we have tacitly assumed that consciousness is an integral part of the complex of bodily functions. This assumption lies at the basis of most modern work in the field of comparative psychology and rests on the thoroughly scientific basis of a large body of observation and inference. In the nature of the case demonstrative proof is impossible, for consciousness as I know it is a purely individual experience; but without the assumption that like behavior in other men implies experience like my own in similar circumstances the science of psychology can not go on, and without the further assumption that other animals have like experience in proportion as their behavior is like my own comparative psychology is an impossible science.

Now keeping in mind the dynamic conception of the workings of the nervous mechanism developed above, let us see whether the introspective examination of some very simple conscious reaction can be put into scientific relation with other biological processes, or whether it must be left out of our science in the cold isolation of mere epiphenomena and similar metaphysical abstractions.

An unfamiliar or unexpected sensation is experienced; let us say a noise. There is a moment of hesitancy while the sensory stimuli, numerous awakened memory vestiges, each perhaps with its own emotional coloring, and many half-formed impulses, surge in consciousness. When the problem presented by the new situation is solved, the mental tension is relieved and the intellectual process crystallizes at once into action. I *am thinking* about it no longer: I *have got* an idea; and the appropriate act follows immediately and automatically unless inhibited by some extraneous influence. Here we have an active and complex interplay of conscious elements corresponding to what in the objective manifestation we called the anticipatory phase of the reaction, and the conscious process comes to an abrupt end as soon as it passes over into the already stereotyped form of reaction. That is, *this* conscious process ends, though of course it may be followed at once by another similar chain of events.

Here we see how intelligence and feeling are developed as the servants of action. They do not appear so long as the action can be effected without them and they vanish as soon as the reflex machinery of an adaptive action is set in motion. *Consciousness is a functional phase of the more complex mechanism of those higher non-stereotyped actions for which the reflex machinery is inadequate, in much the same way that the tropisms of Paramecium and the sucking reflex of an in-*

fant are functional phases of the simple inborn neuro-muscular mechanisms of these organisms.

We do not know whether any glimmer of consciousness is involved in these simple processes; but if we study the behavior of the whole series of animals from *Amœba* to man *objectively,* we can find no point where to an outside observer the behavior which we called discriminative reaction in a protozoan passes over into conscious choice as we see it in our fellow men. The series of stages is complete and unbroken until I begin to study *my own* choices, when I find by introspection that the whole mental fabric is involved—ratiocination, swayed perhaps now this way, now that, by waves of feeling, and finally will. Out of the psychic chaos of hesitation and doubt I say, and I say truly, "I have made up my mind," and action results.

Now this seems to me a very different thing from the discriminative reaction of an amœba, or even the deliberately judicious act of a fellow man. Both of the latter are alike in that *I* do not directly experience feeling, will, etc., in connection with them. Possibly if I could be successively for a time an amœba, a sea anemone, a frog, a man and all the types of animals between by the act of some benevolent Buddha, and if I could carry my memory of each stage through all of the others, then perhaps the psychic series would appear at the end a simple and unbroken graded series, as the objective physiological series does to me now.

Meanwhile, without intending at this time to penetrate far into a field of philosophical speculation which clearly lies beyond the present limits of biological science, I wish to make one further observation on the great problem of the relation of mind and body. We have seen that animal bodies can be arranged in a graded series (not a simple *linear* series, to be sure, but a true series, nevertheless) of genetically related forms; that animal activities can be arranged in a similar graded series of functions; and that these two series are closely related. In fact, they are absolutely inseparable except by logical abstraction or some artificial scientific procedure, for their respective members are related to each other as structure and function, as objects and their properties, and neither can exist apart from the other.

There is, however, a third series, the psychic series, of which I know *directly* only one member—my own experience. But I have satisfactory indirect evidence that the psychic series also extends for at least a part of the distance parallel with the other two. And wherever I can analyze this evidence it teaches that psychic processes, like physiological processes, are related to living bodies as functions of their structures. If it be permissible to generalize from these facts, and say that both physiological and psychological processes may be included in the one category of function, we may conclude that we have not to reckon in science with three independent genetic series, anatomical, physiological and psychological, but with one—a single series of functioning structures, whose genetic continuity is unbroken from its simplest to its most complex members and which can be dissociated, as is commonly done, only by doing violence to truth.

The present isolated position of the three disciplines of anatomy, physiology and psychology is due partly to the exigencies of practical pedagogical and methodological convenience and partly to our incomplete knowledge of the facts.

It is perhaps well to add that the position here defined is as far removed as

possible from that naïve materialism which would postulate a single series of objects as the ultimate realities with more or less adventitious functions pertaining to them as epiphenomena. The analysis here attempted is merely pragmatic and proximate, not ultimate, and it leaves quite to one side and untouched the metaphysical problem of the ultimate nature of the phenomenal series, whether it is materialistic or idealistic or both or neither.

Looking back now over the field which we have traversed, in our analysis of the behavior of animals and its mechanisms we start with the tropism and the reflex. This type of response is in some of its simpler phases indistinguishable from the reactions of dead machines to the forces which actuate them. But the more complex reflexes, on the other hand, grade over into those behavior types which we call intelligent. No one has yet succeeded in formulating a clear-cut definition of the limits of the reflex at either its lower or its higher extreme, and perhaps no one ever will; for the whole list of behavior types from machines to men probably forms a closely graded series.

Even the simpler reflexes exhibit a measurable refractory phase, or pause, in the center where the afferent impulse is made over into the efferent. When reflexes are compounded, there is another factor which may tend to modify or delay the response. This is the dilemma which arises when two or more reflex centers are so related that a given afferent impulse coming to one of them may take any one of several final common paths to the organs of response. The reflex response which actually emerges in such a case will generally be the adaptive one, *i. e.*, the one which is best for the organism. The selection of the adaptive response in such a case may be termed *physiological choice*, and it always involves a lengthening of the refractory phase.[5] In the neural tensions of the refractory phase of physiological choice we find the germs of the complex anticipatory reactions which in turn have nurtured the awakening intelligence.

I have atempted to illustrate the thesis that the comparative study of animal behavior in the broadest sense of the term is as essential as other branches of physiology to the comprehension of animal structures and that the enlargement of our knowledge of scientific fact in this field will contribute greatly to the more perfect integration of the three great branches of biology—anatomy, physiology and psychology—and the correlation of the whole with other departments of knowledge. Our philosophy of nature is sound just in proportion as we succeed in effecting these correlations of experience.

C. JUDSON HERRICK

THE ALASKAN FUR-SEALS[1]

WHEN, on January 1, 1909, the management of the Alaskan fur-seal fisheries was transferred to the United States Bureau of Fisheries, the Secretary of Commerce and Labor designated Dr. David Starr Jordan, Dr. Leonhard Stejneger, Dr. C. Hart Merriam, Dr. Frederic A. Lucas, Dr. Chas. H. Townsend, Hon. Frank H. Hitchcock and Hon. Edwin W. Sims, to act as an advisory board to recommend measures designated to conserve this valuable animal life now being exterminated through sea-killing of breeders. On November 23, last, this board met at the Bureau of Fisheries in Washington and adopted the following recommendations, which

[5] Physiological choice, in fact, is not dependent upon a nervous system at all, but has been demonstrated in rudimentary form even among Protozoa, though it remains on a very low plane in these organisms.

[1] Published by permission of Hon. Geo. M. Bowers, U. S. Commissioner of Fisheries.

were placed in the hands of the Secretary of Commerce and Labor:

Recommendations.—Agreed on by the Advisory Board Fur-Seal Service (Dr. David Starr Jordan, chairman; Dr. Leonhard Stejneger, Dr. Frederic A. Lucas, Mr. Edwin A. Sims and Dr. Charles H. Townsend), in conference with the Fur-Seal Board (Dr. Barton Warren Evermann, chairman; Mr. Walter I. Lembkey and Mr. Millard C. Marsh), the Commissioner of Fisheries (Hon. Geo. M. Bowers), the Deputy Commissioner of Fisheries (Dr. Hugh M. Smith), Assistant Fur-Seal Agent, H. D. Chichester, and Special Scientific Expert, Mr. Geo. A. Clark, at a meeting held at the Bureau of Fisheries, November 23, 1909, all the above-mentioned persons being present, and the action on each recommendation being unanimous.

1. It is recommended that the agent in charge, fur-seal service, shall, under the direction of the Secretary of Commerce and Labor, have full power to limit or restrict the killing of fur-seals and blue foxes on the Pribilof Islands to any extent necessary and that no specified quota be indicated in the lease.

2. It is recommended that, for the present, no fur-seal skin weighing more than 8½ pounds or less than 5 pounds shall be taken, and that not more than 95 per cent. of the three-year-old male seals be killed in any one year.

3. It is recommended that there be adopted a system of regulations similar to those in force on the Commander Islands, the government to assume entire control in all essential matters pertaining to the fur-seals, blue foxes, natives and the islands in general, and the lessee to be restricted to the receiving, curing and shipping of the skins taken.

4. It is recommended that there shall be added to the personnel of the fur-seal service a chief naturalist who shall have charge of all matters pertaining to the investigation, study and management of the fur-seal herd, the blue foxes, and all other life on the islands, and who shall give advice to the agent in charge regarding the number of seals and foxes to be killed each season. The chief naturalist should be a man of recognized standing and experience, and his salary should be not less than $3,000.

It is also recommended that there be at least one assistant naturalist whose salary should not be less than $1,800.

5. It is recommended that the agent in charge shall have control of all administrative matters, and in case of a difference of opinion between the chief naturalist and the agent in charge, the decision of the latter shall govern, pending an appeal to the Secretary of Commerce and Labor.

6. It is recommended that there be arranged a conference of scientific men and diplomats of Great Britain, Canada, Japan, Russia and the United States, for consideration of the question of pelagic sealing as well as of an international game law to protect whales, walrus, sea-otter and other mammals of the sea, the agreement reached by these nations to be submitted to the other maritime nations for their concurrence.

In addition to the above, the conference unanimously adopted the following resolution:

Resolved, That we thoroughly approve of the sentiments set forth in the letter of the Commissioner of Fisheries, dated November 17, 1909, addressed to the honorable, The Secretary of Commerce and Labor, in which was urged the necessity of early action which will result in the stopping of pelagic sealing.

THE KUSER ASIATIC EXPEDITION

ON December 29 Mr. C. William Beebe, Curator of Birds in the New York Zoological Park, sailed on the *Lusitania* for London, accompanied by Mrs. Beebe. Mr. Bruce Horsfall, artist, will follow on a later steamer. After several weeks' study of the pheasants in the British Museum, Mr. Beebe will proceed direct to Ceylon and India, where field studies will be made of the wild pheasants and jungle fowl. The object of the expedition is to obtain data, both written, photographed and painted, concerning the ecology of the Phasianidæ. The tentative itinerary includes the Himalayas, Burma, Sumatra, Java, Borneo, Cochin China, Palawan, Formosa, eastern China and

Japan, the party returning by way of Honolulu and San Francisco.

Mr. Beebe has been granted a twelve months' leave of absence without pay, and in his absence his correspondence and the continuing of his experimental work at the Zoological Park will be carried on by Mr. Lee S. Crandall.

The results of the expedition will be published in monographic form, illustrated with colored plates of all the more important species of pheasants, by Charles R. Knight, Louis Agassiz Fuertes and Bruce Horsfall. The treatment will be rather from the point of view of the ecology of the living birds and their care in captivity, than systematic and anatomical.

Living specimens of Argus and other rare forms will be brought back together with as complete a collection of skins, and studies for backgrounds. The wide-spread interest in pheasants in this country and the lack of knowledge of their habits in a wild state seem to indicate a field for such a work.

The expedition will be made, and the monograph published under the auspices of the New York Zoological Society. Credit for the inception and the entire financing of the expedition and monograph, is due to Colonel Anthony R. Kuser, of Bernardsville, New Jersey. The success of the undertaking will be altogether due to that gentleman's enthusiastic love of birds and disinterested generosity.

Mr. Beebe is in charge of the bird collection and the experimental station at Faircourt Aviaries on Colonel Kuser's estate, and the painting and all other monographic work will be carried on at that place.

MUNICIPAL CHEMISTRY

THE department of chemistry of the College of the City of New York offers during the spring semester a course of thirty lectures on the chemistry of daily life. These lectures will be open to three classes of hearers: (1) Senior students of the college who have complied with the requirements of the department. (2) Employees of the city who have studied sufficient chemistry to pursue the laboratory work. (3) A limited number of auditors composed of citizens of the city will be admitted on applying for a seating to the director of the department. The lectures will be given at 4 P.M., in the Doremus Lecture Theater, Chemistry Building, 140th Street and Convent Avenue, Plaza Entrance.

The program is as follows:

February 4—"Sanitation" (introductory lecture), by Professor Charles Baskerville, director of the department of chemistry, College of the City of New York.

February 9—"Drinking Water and Disease," by Dr. William P. Mason, professor of chemistry, Rensselaer Polytechnic Institute, Troy, N. Y.

February 10—"Sources of Municipal Water Supply," by Dr. William P. Mason.

February 11—"The Purification of Polluted Water," by Dr. William P. Mason.

February 15—"Milk," by Dr. Thomas C. Darlington, commissioner of health, New York City.

February 18—"The Purpose, Method and Extent of Food Adulteration," by Dr. Harvey W. Wiley, chief, Bureau of Chemistry, U. S. Government, Washington, D. C.

February 19—"The Remedy of Food Adulteration and Relation of Chemistry thereto," by Dr. Harvey W. Wiley.

February 25—"Food Inspection," by Mr. Bayard C. Fuller, chief food inspector, New York City.

March 1—"Spoiled Foods," by Mr. Bayard C. Fuller.

March 4—"Drugs and their Adulteration," by Dr. Virgil Coblentz, professor of chemistry, College of Pharmacy, Columbia University.

March 8—"Methods for Detecting Adulteration," by Dr. Virgil Coblentz.

March 11—"Habit Inducing Drugs," by Dr. Virgil Coblentz.

April 1—"Automobile Traffic and the Road Problem," by Dr. Allerton S. Cushman, acting director, Bureau of Roads, U. S. Department of Agriculture, Washington, D. C.

April 2—"Modern Road Construction," by Dr. Allerton S. Cushman.

April 5—"Street Sanitation," by Hon. William H. Edwards, commissioner of street cleaning, New York City.

April 8—"Disposal of Ashes and Light Rubbish," by Mr. Edward D. Very, sanitary engineer, department of street cleaning, and representative of the New York Sanitary Utilization Company.

April 12—"Disposal of Garbage," by Mr. Edward D. Very.

April 15—"Disposal of Putrescible Materials," by Mr. Edward D. Very.

April 19—"Manufacture of Gas," by Dr. Arthur H. Elliott, chemist to the Consolidated Gas Company, New York City.

April 22—"Means of Testing the Properties and Quality of Gas," by Dr. Arthur H. Elliott.

April 26—"The Smoke Problem," by Dr. Arthur H. Elliott.

April 29—"Ventilation," by Dr. Herbert R. Moody, associate professor of chemistry, College of the City of New York.

May 3—"The Chemistry of Personal Hygiene," by Dr. Thomas A. Storey, director of the department of physical education, College of the City of New York.

May 6—Dr. Charles Edward A. Winslow, biologist in charge Sanitary Research Laboratory, Boston, associate professor-elect of biology, College of the City of New York.

May 10—"Paint and Painting," by Mr. Maximilian Toch, chairman New York Section, Society of Chemical Industry, and paint expert.

May 13—"Corrosion of Metals and its Prevention," by Mr. Maximilian Toch.

May 17—"Cement and Concrete," by Mr. Maximilian Toch.

May 20—"Combustibles and the Causes of Fires," by Dr. A. A. Breneman, expert to the Municipal Explosives Commission, New York City.

May 24—"Methods of Extinguishing Fires," by Dr. A. A. Breneman.

May 27—"City Parks, Gardens and Playgrounds," by Dr. N. L. Britton, director of the Botanical Gardens, Bronx Park, New York City.

COMPULSORY CONCENTRATION AND DISTRIBUTION OF STUDIES IN HARVARD COLLEGE

IN pursuance of the resolutions of the governing board of Harvard University, printed in SCIENCE for December 17, the Faculty of Arts and Sciences, at its meetings on December 14 and 21, adopted the following rules, which will go into effect with the class entering in 1910:

I. Every student shall take at least six of his courses in some one department, or in one of the recognized fields for distinction. In the latter case four must be in one department. Only two of the six may be courses open to freshmen or distinctly elementary in character.

II. For purposes of distribution all the courses open to undergraduates shall be divided among the following four general groups. Every student shall distribute at least six of his courses among the three general groups in which his chief work does not lie, and he shall take in each group not less than one course, and not less than three in any two groups. He shall not count for purposes of distribution more than two courses which are also listed in the group in which his main work lies. The groups and branches are:

1. Language, Literature, Fine Arts, Music.
   (*a*) Ancient Languages and Literatures.
   (*b*) Modern Languages and Literatures.
   (*c*) Fine Arts, Music.
2. Natural Sciences.
   (*a*) Physics, Chemistry, Astronomy, Engineering.
   (*b*) Biology, Physiology, Geology, Mining.
3. History, Political and Social Sciences.
   (*a*) History.
   (*b*) Politics, Economics, Sociology, Education, Anthropology.
4. Philosophy and Mathematics.
   (*a*) Philosophy.
   (*b*) Mathematics.

The committee was granted authority to arrange the various courses under the different groups and sub-groups by agreement with the departments in which the courses are given.

III. Prescribed work shall not count either for concentration or distribution.

The Committee on the Choice of Electives was instructed in administering these general rules for the choice of electives by candidates for a degree in Harvard College to make exceptions to the rules freely in the case of earnest men who desire to change at a later time the plans made in their freshman year, and to make liberal allowances for earnest students who show that their courses are well distributed, even though they may not conform exactly to the rules laid down for distribution. In making exceptions to the rules, a man's previous training and outside reading are to be taken into account.

SCIENTIFIC NOTES AND NEWS

Dr. A. A. Michelson, professor of physics in the University of Chicago, has been elected president of the American Association for the Advancement of Science for the meeting to be held next year at Minneapolis. Vice-presidents of the sections have been elected as follows:

Section A—Mathematics and Astronomy—Professor E. H. Moore, University of Chicago.

Section B—Physics—Dr. E. B. Rosa, Bureau of Standards, Washington, D. C.

Section C—Chemistry—Professor G. B. Frankforter, University of Minnesota.

Section D—Mechanical Science and Engineering—Professor A. L. Rotch, Blue Hill Meteorological Observatory.

Section E—Geology and Geography—Dr. John M. Clarke, state geologist of New York, Albany, N. Y.

Section F—Zoology—Professor Jacob Reighard, University of Michigan.

Section G—Botany—Professor R. A. Harper, University of Wisconsin.

Section H—Anthropology and Psychology—Professor Roland B. Dixon, Harvard University.

Section I—Social and Economic Science—The Hon. T. E. Burton, Cleveland, Ohio.

Section K—Physiology and Experimental Medicine—Professor F. G. Novy, University of Michigan.

Section L—Education—President A. Ross Hill, University of Missouri.

Permanent Secretary—Dr. L. O. Howard, Washington, D. C.

General Secretary—Professor Frederic E. Clements, University of Minnesota.

Secretary of the Council—Professor John Zeleny, University of Minnesota.

Secretary of the Section of Social and Economic Science—Fred C. Croxton, Washington, D. C.

At the recent Boston meeting of the American Society of Naturalists, Dr. D. T. MacDougal, director of the department of botanical research of the Carnegie Institution, was elected president and Dr. Charles R. Stockard, of the Cornell Medical School, secretary.

Professor W. D. Bancroft, of Cornell University, has been elected president of the American Chemical Society. The councillors at large elected were: A. D. Little, of Boston; Dr. Leo H. Baekeland, of Yonkers, N. Y., and Professor W. L. Dudley, of Vanderbilt University.

Professor W. B. Pillsbury, of the University of Michigan, has been elected president of the American Psychological Association.

At the recent annual meeting of the New York Academy of Science, Professor James F. Kemp was elected president and Dr. Geo. F. Kunz, Dr. Chas. B. Davenport, Professor William Campbell, Dr. Maurice Fishberg, vice-presidents. Honorary members were elected as follows: Dr. F. K. Göbel, professor of botany in the University of Munich; Dr. Paul Groth, professor of mineralogy, University of Munich, Professor Alfred Lacroix, Musée d'Histoire Naturelle, Paris, Dr. August Weismann, professor of zoology, University of Freiburg.

At the fifth annual meeting of the Southern Society for Philosophy and Psychology, held at Charlotte, N. C., on December 28, 1909, the following officers for the year 1910 were elected: *President,* Edward Franklin Buchner, Johns Hopkins University; *Vice-president,* Shepherd Ivory Franz, George Washington University; *Secretary-treasurer,* Robert Morris Ogden, University of Tennessee. A. Caswell Ellis, University of Texas, and David Spence Hill, Peabody College for Teachers, were elected members of the council to serve two years, and Bruce R. Payne, University of Virginia, and Haywood J. Pearce, Brenau College, to serve three years.

Dr. Emil Fischer, professor of chemistry at Berlin, has been given an honorary doctorate in the natural sciences by the University of Brussels.

M. Simon has been elected a corresponding member of the Paris Academy of Sciences, in the section for anatomy and zoology.

Lieutenant Colonel D. Prain, director of the Kew Botanic Gardens, and Dr. F. O. Bower, professor of botany at Glasgow, have been elected corresponding members of the Munich Academy of Sciences.

An oil painting by Mr. William Churchill of Professor William T. Sedgwick, head of

the department of biology of the Massachusetts Institute of Technology, has been presented to the institute by past students and associates. The portrait will be hung in the near future with appropriate ceremonies.

M. E. YSEAUX, professor of zoology and paleontology at Brussels, has retired from active service.

MR. HENRY B. HEDRICK, for many years assistant in the Nautical Almanac, U. S. Naval Observatory, has received an appointment in astronomy at Yale University, beginning January 1, 1910.

PROFESSOR WILLIAM MORRIS DAVIS gave a lecture before the geological department of Colgate University on the evening of December 20. His subject was, "The Italian Riviera Levante."

DR. J. C. BRANNER, professor of geology in Stanford University, will read a paper on "The Geology of the Black Diamond Regions of Bahia, Brazil" before the American Philosophical Society at the meeting on January 7.

A MONUMENT in memory of the eminent surgeon, Jules Péan, was unveiled before the hospital which he founded and which bears his name, on December 17. The address was made by M. Alfred Mézières, in the presence of the president of the republic and other distinguished guests.

SIR ALFRED JONES, who was largely responsible for the foundation and support of the Liverpool School of Tropical Medicine, has bequeathed the residue of his estate to public purposes to be selected by his executors, but with an indication favoring the School of Tropical Medicine. The estate is large, but the amount that will be available for public purposes is not known.

DR. P. FENNER, professor of geodesy in the Technical School at Darmstadt, has died at the age of fifty-six years.

THE fourth Congress for Experimental Psychology will meet at Innsbruck on April 19.

A FREE exhibition of 700 photographs illustrating the flora, fauna and scenery of central and western China was opened at Horticultural Hall, Boston, on December 27, to last two weeks. These photographs are the property of Arnold Arboretum, and were made by Mr. E. H. Wilson, the head of the Arboretum botanical exploration expedition, during the years 1907–8.

THE council of the New York Academy of Medicine announces that the income of the Edward N. Gibbs fund, amounting to five hundred dollars a year, will be granted for a period of years to a qualified worker to be selected by the council from those who may apply for its use in research in the clinical, pathological or chemical problems of diseases of the kidney.

THE Women's Medical Association of New York City offers the Mary Putnam Jacobi fellowship of $800 available for post-graduate study. It is open to any woman graduate in medicine. Applications should be forwarded to the chairman of the committee on award, Dr. Emily Lewi, 35 Mt. Morris Park, W., New York City.

THE following telegram, dated December 31, has been received at the Harvard College Observatory from Professor E. B. Frost, director of the Yerkes Observatory. "Prismatic camera shows light of Halley's comet to be now largely due to third cyanogen band."

DRS. JOHN F. ANDERSON and Joseph Goldberger, of the Hygienic Laboratory, U. S. Public Health and Marine-Hospital Service, who have been in Mexico City since November 1 studying typhus fever, have issued two notes on their work of much interest as to this disease. In the first paper they showed that Mexican typhus fever is not identical with Rocky Mountain spotted fever. In their second paper they report negative results in all their cultures. By the inoculation of blood from cases of typhus fever in two monkeys a course of fever resembling that in cases of human typhus was produced, ending in crisis in one case on the tenth day and the other on the thirteenth day. These papers were published in the Public Health Reports of December 10 and 24, 1909. Now that an animal susceptible to the disease has been found, it is hoped their

studies may result in determining the mode of transmission of this disease.

The course of lectures delivered by the Kaiser Wilhelm professor in Columbia University, Professor Carl Runge, of the University of Göttingen, is to be published in book form by Columbia University. The subject of the lectures is "Graphical Methods in Mathematics and Physics." The lectures treat of a subject which has not received sufficient attention either in this country or abroad. A considerable amount of the material contained in the lectures is original with Professor Runge. The methods studied have many important applications in astronomy, physics, engineering and various departments of technology.

The proper manipulation of the microscope requires an adequate knowledge of the optical and mechanical principles underlying its construction. As an adjunct to their treatise on the "Manipulation of the Microscope" by Edward Bausch, the Bausch & Lomb Optical Company has recently issued a chart of the microscope stand. Side by side are shown a perspective view and a vertical cross-section of the most modern type of instrument. The different parts and accessories are lettered and named and the path of the rays and the formation of the various images is shown. The chart, 3′ 6″ by 4′ 7″ in size, is executed in colors and mounted on cloth, with rollers at the top and bottom. It is a useful addition to the equipment of the laboratory and is now being distributed to the leading scientific institutions of the country.

Dr. Joseph E. Pogue, who is in charge of the Division of Mineralogy in the U. S. National Museum, has recently described in the Smithsonian "Miscellaneous Collections" a remarkable specimen of pyrite studded with crystals of gold and partly covered with plates of galena from the Snettisham District near Juneau, southeast Alaska. The pyrite is in the usual form of a cube, but what is very remarkable is that there are on it more than one hundred and thirty well-defined crystals of metallic gold. These are also in the cubical system and from one third to one half buried in the pyrite, never more, and seem to have no definite relation to the crystallization of the pyrite. Similarly crystals of galena and chalcopyrite are found on the pyrite. The structure and relation of the galena to the pyrite is of considerable scientific interest and is described in technical detail by the author.

UNIVERSITY AND EDUCATIONAL NEWS

An endowment fund of $500,000 for Trinity College has been raised.

Mr. N. T. Kidder has assumed the expense of the addition now being built for the Gray Herbarium, Harvard University, amounting to about $11,000. The corporation has voted to have this addition called the Kidder Wing.

Albert P. Sy, Ph.D., has been appointed professor of chemistry and director of chemical laboratories at the University of Buffalo, to succeed Dr. H. M. Hill, who resigned last summer.

Dr. E. C. Moore, superintendent of schools at Los Angeles, Cal., has been elected to the newly established professorship of education at Yale University and has accepted.

M. E. Balize, of Nancy, has been appointed professor of organic chemistry, at Paris, and is succeeded at Nancy by M. Grignard.

M. Lameere has been appointed professor of zoology and comparative anatomy at Brussels.

DISCUSSION AND CORRESPONDENCE

THE LUMINOSITY OF TERMITES

In Science of October 22, 1909, XXX., 574–575, Mr. Frederick Knab points out that the mounds made by certain Brazilian termites, or possibly the termites themselves, are luminous.

Although I have seen many thousands of the mounds made by termites in all parts of Brazil, I do not remember ever having observed this luminosity. A specimen of the nest materials was lately sent me by a Brazilian friend from the vicinity of Queluz, in

the state of Minas Geraes. This material shows no signs of luminosity at present, though it does not follow, of course, that it never was luminous.

The following note which I translate from "Viagem ao redor do Brazil," 1875–1878, pelo Dr. João Severiano da Fonseca, Rio de Janeiro, 1880, page 353, is much more to the point:

> On the head waters of Rio Verde (state of Matto Grosso, Brazil) we saw one night a surprising sight. One of the white ants' nests seemed to be covered with little lights, and these tiny stars made it look like a miniature tower brilliantly illuminated. It was near the tent of Captain Craveiro, the commander of the troops, and that gentleman invited us to share his surprise and pleasure. When the nest was struck with a stick the miniature lights went out as if by enchantment, but only to reappear again little by little, beginning where the blows had been weakest.

I know but one other reference to this phenomenon in the works of Brazilian travelers, and that is the following brief note given in Castelnau's "Expédition dans les parties centrales de l'Amérique du Sud, Histoire du Voyage," Paris, 1850, Vol. II., p. 103. In describing the travels in the neighborhood of the city of Goyaz the author says:

> On the night of the fifteenth in the vicinity of the Agoa Limpa estate we noticed a luminous mass in the middle of the campo that aroused our curiosity greatly. On approaching it we found it to be a termites' mound from which shone a great number of small points of light [petits foyers lumineux]. This phenomenon is produced by the presence of an immense number of small phosphorescent larvæ which withdrew into the galleries they had built when one tried to capture them.

The fact that I have lived and traveled in Brazil for ten years without ever having seen this luminosity at all; the surprise of Dr. Severiano da Fonseca at seeing a single instance in Matto Grosso; and the note by Castelnau, who traveled through tropical South America for four years, all lead me to surmise that this luminosity is probably confined to some particular species, or possibly to some special occasions or conditions of termite life.

J. C. BRANNER
STANFORD UNIVERSITY, CAL.,
December 13, 1909

CORRELATIONS OF CLIMATIC CHANGES

HAVING taken into consideration the yearly mean temperatures of 1891 to 1900, from all available sources, and after having discarded all doubtful records, I have drawn maps representing the geographical distribution of annual departures from the normal temperatures, the means of the ten years' observations being considered as normal values. On those annual maps I call thermopleions, or simply pleions, the areas occupied by positive departures, antipleions those of negative departures. The pleions and antipleions are bounded by the quasinormal line.

On this line the departures are nil, the values being equal to the ten-year means.

The lines of equal positive and negative departures I call hypertherms and hypotherms. The pleions represent inflections of the isothermal lines towards the pole, or, more properly speaking, towards the regions of colder climate.

The antipleions, on the contrary, characterize a local abnormal descent of the isotherms towards the equator.

The maps of successive years, for the same country and those of different countries for the same year, show remarkable correlations in the distribution of the departures.

A pleion, in most cases, exists during several years, moving from place to place. When one compares the different maps, and especially those of European and Asiatic Russia, one is led to believe that the pleions are produced by immense waves intercrossing. It seems that for the whole world, the years are either too warm or too cold following the predominance of pleions or antipleions. For example, the year 1893 was exceptionally cold, 1900 on the contrary was too warm. The temperature of the earth's atmosphere was at least one half a degree Centigrade higher during the year 1900 than during 1893. It is a notable fact that neither the Alps, the Caucasus nor the Rocky Mountains form barriers,

not even the Himalayas interrupt the progress of a pleion or an antipleion. This demonstrates the fact that the thermopleions and antipleions are products of temporary alterations of the general circulation of our atmosphere. A full discussion of the question of which this is but a short summary is to be found in my memoir "L'Enchaînement des Variations Climatiques," published recently by the Belgian Astronomical Society. I am working at present on the dynamical problems connected with the results I have already obtained and hope to be able, in a short time, to propose a method of research by which it will be possible to successfully predict, several months in advance, the climatic anomalies of the different seasons of the year. In connection with this study I intend to examine the yield of cotton and grain.

HENRYK ARCTOWSKI
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WASHINGTON, D. C.

THE EFFECTS OF PROLONGED RAPID AND DEEP BREATHING

IN SCIENCE, December 3, D. F. Comstock calls attention to certain phenomena that follow upon a few minutes of enforced deep breathing. These phenomena, as he reports them, are in brief: (1) an apnœic pause, (2) mental stimulation, (3) increased physical endurance and (4) increased pulse rate.

Several years ago I published[1] the results of fairly extensive experiments upon the effects of forced respiration. A comparison of my results with those of Comstock may not be without interest.

In the first place, the apnœic pause is unquestioned. Some of my observers, without endeavoring to hold the breath at all, as did Comstock, furnished respiratory tracings in which two minutes of forced breathing was followed by two minutes of complete apnœa. A very common result was, however, not a pure apnœa, but a period of slow, shallow respiration with long expiratory phases.

Second, the immediate subjective effects of forced breathing were more or less dizziness, tingling and prickling sensations in the hands and feet, blackness before the eyes, and a feeling of confusion coupled with energy. There was often, too, a secondary experience of exhilaration.

Third, immediately after the cessation of forced breathing there was a noticeable improvement in strength and endurance of grip.

Fourth, a slight quickening of pulse occurred during the breathing, though not by any means so pronounced as that reported by Comstock.

Fifth, and most interesting: actual tests of reaction time, discrimination time, memory-span, visual discrimination of forms and precision of movement, all showed more or less impairment when administered immediately after forced respiration.

It is commonly stated that, while alcohol produces for a time distinct exhilaration and a feeling of exceptional mental readiness and fluency of thought, the actual performance under these conditions does not measure up to one's subjective estimate of it. I suggest, therefore, that, contrary to Comstock's view, forced breathing is probably not so valuable as a mental stimulant as it may appear on the strength of the feeling of exhiliration which it develops. My experiments, however, have no bearing upon the effect of forced breathing during longer intervals of time after normal breathing has been resumed.

GUY MONTROSE WHIPPLE
CORNELL UNIVERSITY,
December 6, 1909

[1] *American Journal of Psychology*, IX., July, 1898, 560–571.

QUOTATIONS

THE ANTIVIVISECTION CAMPAIGN

THE antivivisectionists so-called, that is, the misguided, ignorant, and the fanatics who have no objection to live-broiled lobsters, "live feather" pillows, spring traps for mice, sticky fly paper and other forms innumerable of torture of the brute creation, but shudder at the use of animals for the manufacture of vaccine and antitoxins or for the gaining of knowledge that will aid in saving human life, have opened their annual campaign by an attack on the Rockefeller Institute. A newspaper of this city, whose proprietor is said to have a

reason, though no excuse, for disliking medical men, has begun the publication of affidavits from discharged employees of the institute, picturing the "horrors" of animal experiments, particularly the epoch-making experiments of Carrel on blood-vessel anastomosis and the transplantation of viscera and other parts. It is made to appear that these are revelations of the secrets of the torture chamber, though all that these persons have to tell has already been told time and again in reports to societies and in the medical and other scientific journals, and even in the secular press. Among the horrors mentioned is that the experimenter after grafting a leg on a dog "twisted" it to see if the bones were knitting, and the impression intended to be conveyed is that the limb was turned round and round provoking howls of agony. An experimenter, no matter how "cruel" he was, would not be so foolish as to vitiate his experiment by breaking up the adhesions in this senseless way, and what he did, if he "twisted" the leg at all, was what every surgeon does with a fractured bone to assure himself that union is taking place. Another harrowing detail is that the dogs, when operated upon, under an anesthetic it is admitted, lost more or less blood. Still another is that when one of the operations failed and the dog was in pain he was chloroformed at once so that he should not suffer. And so with all the rest of this well-paid-for matter. The head lines are horrible, but any one of moderate intelligence, reading the affidavits and noting the character of the experiments and that they were always done under anesthesia, can see that they were conducted with no more "cruelty" than any surgical operation on man or beast. Many columns of equally hideous and bloody details could be written from the account of a scrubwoman or a day laborer who was allowed the run of the operating room and surgical wards of a hospital for a day or a week; and the surgeons who were racking their nerves and wearying their flesh in the endeavor to relieve pain and save life could with equal effect be called butchers in the stirring head lines.—*Medical Record.*

SCIENTIFIC BOOKS

Les Zoocecidies des Plantes d'Europe et du Bassin de la Mediteranée. By C. HOUARD, Docteur es sciences Lauréat de l'Institute. 2 vols., 1,247 pp., 2 full page plates and 1,365 figs. Librarie Scientifique. Paris, A. Hermann. 1908.

The plan of this work is especially interesting to botanists since the cecidia are grouped with reference to the host plants instead of the insects or other animals which cause their formation. The host plants are arranged in accordance with Engler & Prantl's "Pflanzenfamilien" and under each species is given the cecidia which occur upon it, with cross references for those species of cecidia which occur on more than one host. Each family of host plants is preceded with a résumé of the characters of the cecidia which occur upon its species. The work records a total of 6,239 species, with descriptions of each. In general, the descriptions are short and clear so that there should be very little difficulty in identifying the species. However, in some cases the data were evidently too meager to enable the author to give complete descriptions.

The figures are clear and for the most part have been copied from the works of the authors who described the species. Following each species of cecidia are the references to the bibliography. Each species is also accompanied by abbreviations which explain the part of the plant on which it occurs, whether it is simple or compound, whether the metamorphosis occurs in the cecidia or in the ground, the time required for its complete development, and the geographical distribution.

Among the host plants are many groups which in America, so far as we now know, have few or no cecidia, viz., the fungi, algæ, liverworts, mosses and ferns. There are also many families of flowering plants, of which the American representatives do not bear cecidia. About one third of the known genera of American cecidia are also common to Europe, but only a very few species are common to both the old and the new world. Of the few species which are common to both Europe

and America, the most conspicuous is the *Phylloxera vastatrix* Plan. of the grape which was introduced from America and has proved so destructive to the vineyards of Europe.

The work also includes a bibliographical index of nearly 400 authors and about 1,200 titles; index tables giving the orders, families, genera and species of the organisms which cause the cecidia; and the families, genera and species of the host plants.

In looking over the bibliographical index our attention is attracted to the names of a few authors who have also contributed to our knowledge of American cecidology, especially that of C. R. von Osten-Sacken, who contributed far more to the American than to the European literature.

Every one in America who has attempted a study of cecidology has experienced great difficulty due to the literature being so involved with other phases of biology, especially entomology, and the author in his preface states that this is also true in Europe and this fact has led to his undertaking this important work.

It will undoubtedly prove most useful not only for the cecidologist, but for the botanists and the entomologists. In fact, the author expresses the hope that the work will be of service to the entomologists, the botanists, the foresters and the agriculturists. The author and his fellow scientists are to be congratulated upon the excellency and usefulness of this work. A most excellent companion piece to this would be a similar work on the mycocecidies.

Cecidology is one of the youngest of the biological sciences in both Europe and America, but has attracted a great deal more attention in Europe than in this country. The greater part of the work has been done by the entomologists, who have naturally been more interested in the insects than in the cecidia. However, the subject is now attracting the attention of the botanists, who are finding it a fruitful field from the standpoint of plant pathology and plant physiology. There are at the present time a number of young workers who are taking up this study and in due time we may expect similar productions in this country.

Mel T. Cook

Delaware Agricultural
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Newark, Del.

Lehrbuch der Pharmakognosie. Von Dr. George Karsten, Professor an der Universität Halle, und Dr. Friedrich Oltmanns, Professor an der Universität Freiburg I. B. Zweite vollständig umgearbeitete Auflage von G. Karstens Lehrbuch der Pharmakognosie. Mit 512 zum Teil farbigen Abbildungen im Text. Jena, Gustav Fischer. 1909.

Pharmacognosy is a comparatively new branch of botanical science, and text-books on the subject are very welcome, particularly if they present a new point of view. In this country the so-called works on materia medica, on which the students of pharmacy and medicine formerly relied for their knowledge of vegetable drugs, are being replaced by works on pharmacognosy, on the one hand, and works on pharmacology on the other. In other words, these two divisions can no longer be covered by a single text or treated with authority by the same author. Thus, pharmacognosy in the modern acceptation of the term deals with the natural origin of vegetable and animal drugs, their physical and morphological characters, and the chemical nature of their constituents, while pharmacology deals with the action of their constituents and preparations on the animal organism, and hence to this latter division properly belongs the consideration of therapeutic properties and doses. It is to the credit of German scientists and teachers that they earlier differentiated these subjects than we in this country.

The work at hand treats of the vegetable drugs exclusively, but, like most of the German works on this subject intended for the use of students, treats only of a limited number of the drugs, these being more or less typical of the various classes. Professor Oltmanns has written the chapters dealing with the cryptogamic drugs, rhizomes, roots, tubers,

flowers and exudation products, while Professor Karstens has considered the woods, barks, leaves, herbs, fruits and seeds. The order of treatment of each drug is somewhat as follows: (1) The botanical origin together with a few words on the distribution of the plant; (2) an historical note on the use of the drug in medicine or in the arts; (3) the external morphology of the drug; (4) the anatomy of the drug; (5) a brief description of the drug in the powdered form, and (6) an enumeration of the important constituents.

The strongest feature of the work is the comprehensive treatment of the macroscopic and microscopic structure, the illustrations being numerous and in part colored. The German point of view of treating a selected number of subjects in a thorough manner is to be commended in a *Lehrbuch*, and looked at pedagogically Karsten and Oltmanns's "Pharmacognosy" is an excellent work.

Henry Kraemer
Philadelphia College of Pharmacy

The Periodic Law. By A. E. Garrett, B.Sc., F.R.A.S. New York, D. Appleton & Co.

This is one of the volumes in the International Scientific Series. The first part of the work is historical, after an introduction giving the methods of determining the atomic weights. Beginning with Prout's hypothesis, the early attempts at classifying the elements are reviewed. It may well be questioned whether undue space and prominence are not given to some of these. In discussing the periodic system itself, the author assigns more credit to Lothar Meyer than Mendeléeff was willing to give him and than I am inclined to think is justly his due. Much prominence is given the important work of Cornelley. The pendulum swing of Professor Spring, of Liége, is attributed to Reynolds and Crookes, and the idea of the spiral, first worked out by Baumhauer, is credited to Johnstone Stoney. A considerable portion of the book is given to the applications of the periodic law and a chapter is devoted to the efforts at stating the relationship between the atomic weights in the terms of a mathematical formula. In the last chapter there is a discussion of the more recent theories as to the nature and structure of the atom and their bearing on the periodic law.

The book is well written and should prove a useful handbook to a student of this important subject.

F. P. Venable

SCIENTIFIC JOURNALS AND ARTICLES

The first number of the *Journal of Pharmacology and Experimental Therapeutics*, edited by Dr. J. J. Abel of the Johns Hopkins University, appeared in June. It contains the following articles, with these results in brief:

1. "The Comparative Toxicity of the Chlorides of Magnesium, Calcium, Potassium and Sodium," by D. R. Joseph and S. J. Meltzer. The order of toxicity of the four chlorides when tested on dogs is magnesium, Ca, K and Na. It is thought that the effect of these chemical substances depends in large part upon the particular substance upon which they act, that is, the effect upon simple tissues is not applicable to complex organs, and the effect upon organs is not applicable to entire animals. The toxicity of alkalies and alkali earths existing as constituents of the animal body is in inverse proportion to the quantities in which they are present in the serum of that animal.

2. "Studies in Tolerance—I., Nicotine and Lobeline," by C. W. Edwards. Tolerance to nicotine or tobacco can be obtained in animals only with great difficulty when the drug is given in small doses. Dogs develop resistance quickly to large toxic doses of nicotine, but to lobeline they gain only a limited tolerance.

3. "Studies in Tolerance—Strychnine," by Worth Hale. Dogs may develop a tolerance to strychnine very slowly and at best in a very imperfect form. Guinea-pigs, owing to their varying degree of sensitiveness, yield results that are somewhat uncertain, though acquired tolerance is suggested.

4. "Mechanism of Hæmolysis, with special reference to the Relation of Electrolytes to Cells," by G. N. Stewart. Evidence, both histological and physico-chemical, is brought forward to support the idea that the super-

ficial layer of the erythrocyte plays an important part in regulating the exchange between the corpuscles and the plasma or other surrounding media. Alterations of the envelope merely allow the conditions to be established which are necessary for the transformation of the hæmochrome. Some evidence is offered in support of the idea that the electrolytes of the erythrocytes may be divided into three fractions: (1) A portion which escapes even with the gentlest methods of laking, (2) one liberated only by energetic laking agents, and (3) one set free only by destructive processes.

5. "Studies Concerning the Iodine-containing Principle of the Thyroid Gland—I.," by S. Strouse and C. Voegtlin. Iodotyrosine has not an analogous effect to that of the extract of thyroid gland upon nitrogen metabolism or upon the blood pressure. It has no curative effect upon myxedema or cretinism, does not exhibit the typical action of the thyroid extract in exophthalmic goiter and finally the negative results of these writers seem to indicate that the activity of the iodine-containing principle of the thyroid gland is not due to a combination of iodine with one single cleavage product of protein.

6. "The Antagonism of the Adrenal Glands against the Pancreas," by C. W. Edmunds. The action of adrenalin in inhibiting the pancreatic secretion is found to be in no sense specific. Nicotine and other drugs that constrict the blood vessels of the gland cause an inhibition of the gland's secretion as does adrenalin, and in a similar manner asphyxia and splanchnic stimulation may produce anæmia of the organ and thereby inhibit secretion.

7. "Quantitative Experiments with the Cutaneous Tuberculin Reaction," by C. J. Pirquet. It is found that the cutaneous tuberculin reaction depends upon at least two factors, one the tuberculin, the other that furnished by the organism, which latter can be considered as an antibody, the origin of which dates back to previous infection of the organism with the tubercle bacilli. The first factor can be varied at will and progressive dilutions are followed by a more or less uniform diminution of the intensity of the reaction, but owing to an imperfect understanding of certain phenomena no definite mathematical expression could be elicited for the determinations made.

The August number of the *Journal of Pharmacology and Experimental Therapeutics* contains the following articles:

1. "Some Convenient Laboratory Apparatus," by A. C. Crawford and H. Honn. An automatic winding device for spring kymographs is described and figured. This device consists of a small motor and a special clamp that can be easily attached to the heavier forms of kymographs resembling the Ludwig-Baltzer type.

A self-registering injection, a nerve stimulating apparatus, and a combined signal and base line apparatus are each figured and described.

2. "The Effect of Caffeine and Sodium Bicarbonate upon the Toxicity of Acetanilide," by Worth Hale. The author concludes that caffeine is of little or no benefit in acetanilide poisoning, in some cases it even exerts a harmful effect. Sodium bicarbonate lessens the toxicity of acetanilide both upon the heart and upon the intact animal.

3. "Anesthesia by the Intracerebral Injection of Magnesium Chloride," by V. E. Henderson. A note describing a laboratory method for anesthetizing rabbits and cats.

4. "Ergot," by W. H. Cronyn and V. E. Henderson. It is held by these writers that most galenical preparations contain considerable amounts of the active principles. The pharmacologic action of the small doses usually prescribed are, however, too slight to elicit the desired effect when given *per os*. Ergotoxine is a highly active alkaloid and has the properties of ergot most desired in medicine, it brings on long enduring vaso-constriction, increases uterine movements when exhibited intravenously, and the same to a less extent when injected subcutaneously, but when given *per os* has very little action.

5. "On the Pharmacological Action of Some Phthaleins and their Derivatives, with Special Reference to their Behavior as Purgatives—I." by J. Abel and L. G. Rowntree.

Phenolphthalein and its halogen products, phenoltetrachlorphthalein and tetrabromphenoltetrachlorphthalein do not differ markedly in their pharmacological behavior. Both phenolphthalein and its tetrachlor derivative are non-irritant when applied to the mucous membrane, to open wounds, and when injected subcutaneously. A subcutaneous injection of 0.40 g. in man causes a laxative action lasting four to six days. This prolonged action along with its low degree of toxicity makes it a hypodermic purgative of much promise. When subcutaneously injected the tetrachlor derivative is absorbed and finally excreted into the bile only. Phenolphthalein administered in the same way escapes in part in the urine, when given *per os* it may appear in small quantities in both bile and urine, but when the tetrachlor compound is given by mouth none of it appears in the bile or in the urine. The large intestine may absorb these drugs from their solution in bile and become thoroughly saturated with them.

6. "Clavin, Vahlen's Active Constituent of Ergot," by D. Vanslyke. A sample of Vahlen's "clavin" showed upon analysis the following content: leucin, 39.1, iso-leucin, 22.3, and valin 37.1 per cent.

7. "The Effect of Collodion on the Amanita-hemolysin." Amanita-hemolysin when dialyzed in collodion sacs loses its hemolytic action completely. Likewise when in contact 24 to 36 hours with granular collodion previously boiled in one per cent. sodium chloride solution and washed with dilute alkalies the hemolysin loses its hemolytic action. Solanin is not affected, but saponin sometimes is.

8. "The Distributions of Poisons in the Amanitas," by W. W. Ford. Nearly twenty species of amanitas were examined and the three most important poisons found in these fungi are muscarine, hemolysins and toxins. By the methods used even one or two plants furnish sufficient analytic material to establish the properties of the fungus suspected of being poisonous.

9. "On the Pharmacological Action of Iodiodoso- and oxyiodosobenzoic Acids," by A. S. Lovenhart and W. E. Grave. Intravenous injections of N/20 solutions of sodium iodosobenzoate or oxyiodosobenzoate acids cause an immediate and marked depression of the respiratory center, which seems to be identical with ordinary apnœa caused by excessive ventilation. This and other physiological phenomena seem to indicate that the oxygen bound to the iodine in iodosobenzoic acid is physiologically active.

AN EARLY NOTE ON FLIES AS TRANSMITTERS OF DISEASE

IN these days when we are just coming to realize what powerful agents insects are in the dissemination of infectious diseases, it is interesting to read on pages 385 and 386 in Edward Bancroft's "An Essay on the Natural History of Guiana in South America," published in London in 1769, concerning a disease called "Yaws" very prevalent in Guiana:

> The Yaws are spungey, fungous, yellowish, circular protuberances, not rising very high, but of different magnitudes, usually between one and three inches in circumference. These infest the whole surface of the body, and are commonly so contiguous that the end of the finger can not be inserted between them; and a small quantity of yellowish pus is usually seen adhering to their surface, which is commonly covered with flies, through the indolence of the Negroes. This is a most troublesome, disagreeable disorder, though it is seldom fatal. Almost all the Negroes, once only in their lives, are infected with it, and sometimes the Whites also, on whom its effects are much more violent. It is usually believed that this disorder is communicated by the flies who have been feasting on a diseased object, to those persons who have sores, or scratches, which are uncovered; and from many observations, I think this is not improbable, as none ever receive this disorder, whose skins are whole; for which reason the Whites are rarely infected; but the backs of the Negroes being often raw by whipping, and suffered to remain naked, they scarce ever escape it.

The "Yaws" according to the Standard Dictionary is: "A contagious tropical skin-disease characterized by small, dusky red spots that develop into raspberry-like tubercles, sometimes ulcerating: often of long continuance: frambœsia."

Bancroft was a physician, who resided on the river Demerara, from which he wrote letters to his brother under dates July 8–November 15, 1766. In 1769, these letters were collected and published in a volume, under the above title, dedicated to William Pitcairn, M.D., fellow of the Royal College of Physicians in London and Physician of St. Bartholomew's Hospital. The copy from which this extract is taken may be found in the Library of Congress at Washington.

E. W. Gudger

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SPECIAL ARTICLES

GLACIATION IN THE SAN BERNARDINO RANGE, CALIFORNIA

While engaged in the study of the mountains of southern California the past summer the writers spent a week about the slopes of San Gorgonio Mountain, the highest point of the San Bernardino range. The important discovery was made of unmistakable signs of former glaciation upon its northern slope. This is a fact of considerable interest because it has hitherto been assumed that the southernmost point of glaciation in the United States was in the Sierra Nevadas, nearly two hundred miles to the north.

The San Bernardino range is topographically distinct from any other mountains of southern California. It appears to be much younger than the San Gabriel range, from which it is separated by the Cajon Pass, and also to have had a different history from the San Jacinto Mountains, which lie to the south on the opposite side of the San Gorgonio pass.

The topography of the range is marked by broad elevated valleys, and plateau-like ridges. There are several undrained basins quite similar to those in the desert immediately adjoining on the north, and it seems reasonable to assume that the range as a whole is an uplifted fault block of what was once topographically a portion of the Mohave desert.

The highest portion of the range forms a rather sharp ridge about six miles long and extending a little north of west and south of east. San Bernardino Mountain forms the western end of this ridge with an elevation of 10,630 feet, while the eastern end is known as San Gorgonio Mountain with a height of 11,485 feet. The Santa Ana River, the main stream in the range, drains the northern slope of this ridge, receiving its large permanent flow of cold water from the glacial gravels and the snow banks which linger late in the season in the heads of the protected cañons.

The largest glacier existed on the northwest slope of San Gorgonio in a semicircular basin made by a northerly curve of the ridge running westerly to San Bernardino Mountain. Here is a true glacial cirque, and from its margins well-characterized morainal ridges extend downward for about a mile into the basin of the South Fork of the Santa Ana River, and block a small tributary from the east. Above the dam thus made is a body of water about a quarter of a mile across known as Dry Lake. The lower marginal moraine reached fully three quarters of a mile below the lake, the total width of the glacier at its lower end being indicated by this distance. The rock débris on its lower side forms a great wall across the valley 300 to 400 feet high. The glacier appears to have been overloaded with débris and after having first reached the lowest point where there is a great quantity of partly modified morainal material, to have been crowded progressively eastward back toward the present Dry Lake. In places two to three marginal moraines appear and several basin-like depressions resembling kettle holes. No bedrock is visible in the path of the glacier and scratched boulders were not recognized with certainty. The granitic rocks are coarse and crumble rapidly and it is not to be wondered at that no boulders thus marked were seen. Great springs issue from the lower margin of these glacial gravels, forming a typical mountain meadow with abundance of grass and a cool bracing air.

Another typical cirque basin lies close up under the northeast crest of San Gorgonio, and contains snow drifts nearly all summer.

A half mile below are one or more well-marked semicircular terminal moraines.

Two miles northwest of San Gorgonio, and in another northeastward facing cirque was a glacier which carried down a vast amount of débris to within a quarter of a mile of the termination of the large glacier already described. A small body of water known as Dollar Lake occupies the last resting place of the ice close up under the rocky cliffs.

Following the ridge westerly for two miles more we come to a cirque-like basin close up under the crest and forming the head of Hathaway Creek. Here was perhaps the most interesting glacier of all in the district. It was a long narrow tongue of ice which reached downward a mile and left the most perfect moraines seen. Five semicircular terminal moraines cross the cañon and upon its eastern side is an ideally perfect marginal moraine. The middle one of the terminal moraines is formed of immense blocks of rock and looked at from below its curving front forms a great wall nearly 100 feet high. The lowest moraine, 1,000 feet farther down the cañon, is formed of the finest material of any, as though when the first ice tongue came down it found the surface soft and deeply disintegrated. The phenomena here indicate that glaciation was of considerable duration, and that the history of the period was anything but simple.

The last glacier on the ridge was a small one nestling also in a northeast-facing alcove near the top of San Bernardino Mountain.

None of these glaciers appear to have descended much below 8,500 feet, and it will be seen from the descriptions given that the conditions had to be just right for their appearance at all. Such conditions were a northward or northeastward facing alcove which headed sufficiently close to the crest to receive the snows which drifted over its summit. The west fork of Hathaway Creek, which headed nearly as high as the glaciated one, was separated from the crest by a plateau-like shoulder and in its sharp V-character appears never to have contained anything of a glacial nature.

There seems to be no other possible interpretation of the phenomena observed but that of glacial action, and it is quite remarkable that this extensive lofty region known to have a heavy precipitation and to contain a boreal fauna and flora should not long before have been investigated in regard to the possibility of its having been glaciated.

H. W. FAIRBANKS,
E. P. CAREY
BERKELEY, CAL.

MALLOPHAGAN PARASITES FROM THE CALIFORNIA CONDOR

THE great vulture or condor of California, *Gymnogyps californianus*, although not as rare a bird as reported by most bird books is yet so uncommon and shy, and hence so rarely seen, and is such an extraordinary great feathered animal, that it is one of the most interesting of American birds. It ranges north and south through the mountains of the state, nesting in wild and inaccessible places. It is nearly, if not quite, as large as the condor of the South American Andes, averaging four and a half feet in length and ten feet in spread of wing. The female lays a single enormous egg ($4\frac{1}{2} \times 2\frac{1}{2}$ inches), specimens of which are rarer in collections than those of the great auk.

Up to the present time no Mallophaga (biting bird lice) have been recorded from this bird giant. However one of my students of several years ago, C. S. Thompson, a student of birds as well as of insects, took a number of Mallophaga from a single condor and I have just taken time to go over this material. It includes only two species, a small *Menopon* and a *Lipeurus* of average size.

The *Lipeurus* belongs to the well-characterized group of sex-guttati (with six curious chitinized spots on the anterior half of the head), whose members are found only on raptorial birds, especially the larger kinds as vultures and eagles. The group affinities of the specimens (two females and a male) are certain, but whether they should be assigned to one of the few already described species of this group or be looked on as representatives of a new form is not so easily determined.

On the whole, I am inclined to align them with Giebel's long-known species *Lipeurus assessor*. Giebel described the species from specimens taken from the South American condor, *Sarcorhamphus gryphus*. Piaget found it again on the same host and Carriker has taken it on the king vulture, *Gypagus papa*, in Costa Rica. As the range of the king vulture and the California condor almost overlap (the king vulture is said to occur occasionally in Arizona) it is, at first thought, not surprising that the single parasite species is common to all three of these great American vultures.

Osborn has found a *Lipeurus* on the turkey buzzard (*Cathartes aura*) in Iowa, but describes is as distinct from *assessor* under the name *marginalis*. His specimens (two) are smaller by a third than *assessor* and have their markings "confined to the narrow marginal lines."

The single *Menopon* specimen, a female, can also, I think, be ascribed to an already known species, namely *Menopon fasciatum*, collected by Rudow from the South American condor (*Sarcorhamphus gryphus*) and by Carriker from the king vulture (*Gypagus papa*). The exact determination of this *Menopon* species is made very difficult, if not impossible, by Rudow's incomplete description, but Carriker's figure and what there is of the original description correspond too well with my specimen from the California condor to make necessary the establishment of a new species for it.

It is highly interesting—at least it is to me—to find two parasitic species common to all three of the great vultures of the American Cordillera. But the range of these birds, although extending north and south for several thousand miles, is nearly continuous when the three species are taken as one host type. Looked at in this way the geographical range of the parasites seems explicable. But when we keep in mind the facts that the host type is really a compound of three taxonomically quite distinct units—they represent three separate genera to the ornithological systematist—and that the individuals of each of these host units are particularly non-gregarious, even solitary, birds, preventing, almost certainly, any actual bodily contact between individuals of the different species and, except at mating and nesting time, any such contact even among individuals of any one of the species—when we face these facts the distribution of these wingless parasite species comes to assume the interest and importance of a problem. What is its solution?

I can simply reiterate my belief, already several times previously declared, that such cases can only be explained on the assumption of the occurrence of the parasite type on the common ancestor of all three of the related (although generically distinct) host types, and its persistence practically unchanged on each of the diverging descent products from this original ancestor-host.

Vernon L. Kellogg
Stanford University, Cal.

FUR-SEALS DOMESTICATED

Until a few months ago, no authentic instance was on record of Alaska fur-seals (*Callorhinus alascanus*) being fed in captivity and living for any length of time in other than their natural environment. Apocryphal tales exist on the Pribilof Islands of fur-seals having been tamed and living thereafter in the habitations of human beings on the islands. In the early seventies, the Alaska Commercial Company placed two immature live fur-seals, exact ages not definitely known, in Woodward's Gardens in San Francisco, which were confined within an enclosure, and which died of starvation after several months' incarceration, having eaten nothing during the interval.

This experiment at Woodward's Gardens fixed the idea that fur-seals would not feed in captivity. In view of this belief, it is specially interesting to announce that Mr. Judson Thurber, boatswain on the revenue cutter *Bear*, has succeeded in inducing two fur-seal pups to take food voluntarily and in keeping them alive and well in captivity from October 9, 1909, until the present time. A brief account of this successful experiment is given.

The effort had its inception in the desire of

Dr. Fox, the surgeon of the *Bear*, to ascertain whether the fur-seal carried ectoparasites. For this purpose, a starving fur-seal pup, whose mother had been killed while feeding at sea, was given to the *Bear's* surgeon, who was unable to discover any of the parasites mentioned. The half-starved little animal was then taken by Mr. Judson Thurber, the *Bear's* boatswain, who desired to attempt feeding the pup by artificial means. He was so far successful in his efforts that he induced this pup to eat dried fish from his hand and kept it in good condition for three weeks, when it died in convulsions. Desiring to carry the experiment farther, Mr. Thurber obtained two well-conditioned fur-seal pups, a male and a female, from the Pribilof Islands on October 9, which he induced to eat regularly and even greedily, and which now are fat and in prime condition.

The chronology of the experiment follows:

October 9.—Two pups delivered to Revenue Cutter *Manning*.

October 14.—Pups delivered by *Manning* to *Bear*—did not eat between these dates.

October 19.—Female began eating solid fish.

October 23.—Male chloroformed and frenum severed.

October 28.—Male induced to swallow a little dried salmon.

November 2.—Male began to eat at will, and on that date ate with evident relish nine small fresh herring at Seattle.

Mr. Thurber began his experiments by forcing condensed milk down the throat of the starving pup first obtained. In doing so he discovered that the animal experienced difficulty in swallowing and attributed this to the fact that the movement of the tongue was restricted by the frenum. This Mr. Thurber at once severed forcibly with his finger, upon which the pup soon after began to eat fish. After the death of this pup and his securing the two others, the same impediment to the free movement of the tongue was noted. The female, it is stated, succeeded in breaking the frenum by her own efforts and a few days afterwards began to eat. The male being unable to do this, on October 23 he was chloroformed and his frenum cut. Immediately after this, the male began to protrude its tongue and to nose the fish in its enclosure, but did not eat, possibly because no suitable food was obtainable at sea. Upon the arrival of the vessel at Seattle small herring were fed to the pups and both animals ate greedily.

The female was by far the easier to feed, was without food for only ten days and has been in good condition during the whole of her captivity. The male, however, was virtually without food from October 9 until November 2, a period of twenty-four days, during which time he grew thin rapidly and was a pitiful sight beside his fat and sleek-looking companion. Since he began feeding, however, he fattened daily and now is as well-conditioned as the female.

The pups have been kept on board the *Bear* in a box six feet long by three feet wide. At first this box was filled with sea-water two or three times a day. Now the box is kept filled with water during the day and is emptied at night. They manifest no desire to leave the water during the day and frequently sleep on the surface. In the morning, when the box is filled with water, they show every indication of delight. They are very tame and, when not in the water, will allow any one to fondle them unless a quick motion is made, when they will snap, but even then will bite gently if the hand is allowed to remain quiet.

In conducting this experiment Mr. Thurber used great patience and no little skill. He began feeding the animals by holding their mouths open and pouring into their mouths evaporated cream mixed with bits of fish. The pups resented this, but small quantities went into their stomachs. Later, Mr. Thurber would tie bits of fish on the end of a string and tease the animals until they would snap at the fish. Then he would manage to poke the fish down the seal's throat and cut off the string. In this way the female was taught the taste for fish, after which she soon learned to eat voluntarily.

These animals, the only captives of their kind in the world, are now thriving on board the *Bear* and it is hoped soon to bring them to Washington, where they will be placed in the large pool at the Bureau of Fisheries. Mr. Thurber is entitled to all credit for his suc-

cess in demonstrating the practicability of a measure hitherto believed impossible of accomplishment. The greater portion of the foregoing data was furnished by Captain E. P. Bertholf of the *Bear*.

The result of Mr. Thurber's experiment is to establish the possibility of feeding fur-seals in captivity. Incidential to this is the interesting disclosure seemingly demonstrated by three examples under observation that the frenum in the fur-seal young at first opposes an obstacle to their taking solid food, and that its rupture is a prerequisite to their feeding on other substances than mother's milk. Should this be proved by subsequent experimentation, the knowledge may open up a wide field of endeavor, having as its object the saving from death of those fur-seal nurslings whose mothers have been killed at sea, and which now die a lingering death from starvation.

Barton W. Evermann,
Walter I. Lembkey
Bureau of Fisheries,
Washington, D. C.

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 462d meeting was held November 27, 1909, with President Palmer in the chair.

Mr. A. S. Hitchcock referred to the many changes in nomenclature in recent years, and pointed out that much of this change was inevitable. He illustrated the changes that must follow from increased knowledge of the history of grasses, by examples from Otto Kuntze and showed how some of Kuntze's conclusions were nullified by an early paper by Rafinesque.

Professor Bartsch, referring to a recent paper by Professor Spillman, called attention to the attempts of Mr. D. H. Talbot, of Sioux City, Iowa, during the eighties to breed a solid-hoofed hog in order to overcome the foot disease. Hog cholera carried off all but two of the selected animals which had only partially solid hoofs. From the progeny of these by selection and breeding a race of solid-hoofed hogs was obtained, specimens of which were seen by the speaker in the early nineties.

The chair called attention to the consummation of what may be considered the first international game preserve. This preserve consists of two separate reservations—one established by the state of Minnesota and the other by the province of Ontario. These two reservations adjoin the international boundary. For several years a bill to establish a game refuge in northern Minnesota has been pending in Congress but has failed to pass. Last February by proclamation of the President the Superior National Forest was established in Minnesota, and shortly after a bill was passed by the state legislature prohibiting the hunting of game animals or birds in national forests, state parks and such other lands in the state of Minnesota as the game commission might set aside as game refuges. Under this law the Superior State Game Preserve, comprising about 1,000,000 acres, and including all of the Superior National Forest and some other lands adjoining the international boundary, has recently been established. Still more recently the province of Ontario has set aside an equal area as the Quetico National Forest immediately adjoining the Minnesota reservation on the north. The combined area of the two reservations is about 2,000,000 acres.

Mr. Howell described a case of semi-domestication of a wild bird, the myrtle warbler, in the drug store of Union Station at Washington. Mr. H. W. Clark noted a somewhat similar instance at Lake Maxinkuckee, Ind., in 1906.

The following communications were presented:

Observations on the Mammals of the Mammoth Cave: A. H. Howell.

The paper gave the results of a visit to the cave in late June and early July. The habits of the cave rat (*Neotoma pennsylvanica*) were described and specimens exhibited which had been captured in the cave. Mention was made of the occurrence of three species of bats in the cave in winter; none is found there, however, during the summer months.

The Distribution of Color in the Seeds of Cowpeas: C. V. Piper.

In the seeds of cowpeas, the following colors are met with where the seed is uniformly colored: black (really very dark violet), violet, maroon, pink, buff, cream, white, marbled brown and buff, speckled blue on buff. In many varieties of cowpeas, however, especially where the body is white, the other color is always distributed in definite types: (1) *Small-eyed* with a small amount of color about the hilum. (2) *Large-eyed* with a large amount of color about the hilum. (3) *Saddled* with a very large amount of color cen-

tering about the hilum. (4) Like (2) or (3), but the color extending over the strophiolar end of the seed. (5) Like (4), but in addition scattered isolated spots. (6) The whole seed colored excepting a small area at the micropylar end. These types of distribution are identical for all the colors, and in this respect the marbled and speckled colors act like simple colors; for example, a cross between whippoorwill, a marbled seed and black eye gives a white seed with a marbled coloring about the eye. It is evident from what hybridizing has been done and the varieties already in existence that there are perfectly definite factors determining the color distribution, the exact details of which will require much further investigation. It is suggestive that the coloring centers about the eye and in the different types extends farther and farther morphologically from the eye, the last part of the seed remaining white being the micropylar end. This is apparently in accordance with the path of nutrient substances entering the seed as the micropylar end is both morphologically and physiologically farthest from the hilum. The distribution of color in the cowpea is much simpler and quite different from what it is in the beans, which have been more carefully studied. In the case of some cowpea hybrids, one color pattern seems to be laid directly over the other as in crosses between marbled and speckled varieties, which results in hybrids having both the marbling and the speckling.

A Painful Skin Disease in Man Caused by a Predaceous and Supposedly Beneficial Mite: F. M. WEBSTER.

Attention was called to epidemics of a dermatitis due to a small mite (*Pediculoides ventricosus*) in various parts of the country. In the east, the presence of these mites among wheat straw was traced to the abundance of the larvæ of the Angoumois grain moth, while in the middle west, its excessive abundance was due to the presence of a wheat joint worm (*Isosoma tritici*).

As wheat straw is used largely in the manufacture of a cheap grade of mattresses, people using these mattresses had experienced painful eruption caused by the mites escaping from the straw and attacking the occupants of the beds on which the mattresses were used. In the middle west, people handling wheat straw, either in thrashing the grain or in bales, had been attacked and suffered from the attacks of the mites. Owing to the fact that this eruptive skin disorder affected whole families, it has been heretofore supposed to be contagious.

M. C. MARSH,
Recording Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

AT the 436th regular meeting of the society, held in University Hall, George Washington University, November 9, 1909, Dr. Edgar L. Hewett, director oi the American School of the Archæological Institute of America, gave an account of the work of the school during the past years. The lecture was illustrated with stereopticon views. Dr. Hewett first described and illustrated the work of the Utah Branch, in immediate charge of Professor Byron Cummings, of the State University of Utah. He threw on the screen views of the large natural bridge and of the two great cliff houses lately discovered on the Navajo National Monument, northern Arizona. Archeological work is now being done on the ruins on this reservation. He showed also the method of work and the results obtained in excavations conducted by the American School at Puye and Rito de los Frijoles, in New Mexico. Excavations at the former place included work on the large community house on the mesa, and on the cliff-dwelling at the base of the cliff. He explained the relation of the casas and the rooms built on top of the talus in front of them.

"The ancient remains of the Rito," said Dr. Hewett, "consist of four community houses in the valley and one on the mesa rim near the southern limit of the cañon, and a series of cliff houses extending for a distance of a mile and a quarter along the base of the northern wall." The excavation at the Rito revealed a type of ruin called a talus village; thirteen of these ruins were recognized.

The field work of the school includes not only excavation of ruins, but also repair of their walls and in some minor cases restoration.

Views were shown of the community house on top of the mesa at the Rito, the trail worn to the summit, an excavated kiva, a restored ceremonial opening, a secular room provided with a fireplace and another with a mill (restored) for grinding corn. It is contemplated to place in the excavated rooms the more common domestic articles found in them, so that in a field museum of this kind these may be viewed in their proper setting.

AT the 437th regular meeting, December 7, 1909, Dr. J. B. Clayton gave an illustrated lecture on "Varying Values of the Cross Symbol."

In common with other universal symbols the cross emblem presents four clearly marked stages in its development, a simple idea, elaboration, sanctity and decadence. The crux ansata of Egypt, which was originally a water gauge beginning with a simple stick set upright on the banks of the Nile to indicate the height of the annual overflow, was elaborated, first, by the addition of a short horizontal bar, thus forming a tau-cross, the masculine symbol sacred in Phœnicia to Tammuz, and later by the sun-circle, finally changed to a loop, making the object a handled cross. Thus juxtaposed, the fertility of sun and waters suggest the generative powers of nature. This symbol appears in the catacombs with the sun circle transformed into a laurel wreath, expressive of the triumphant faith and hope of christians. The first historical appearance of the swastika, fourteenth (?) century B.C., is apparently on a small leaden figure three and a half inches long, found by Dr. Schliemann in the second city of the ruins of Troy together with many crosses of gold, silver, etc., the location of the symbol on the figure having generative significance. The swastika indicated the sun—the feet referring to the rays, then fire and finally life. In India, the swastika (arani) formed by the two firesticks—the feet indicating flames—was the emblem of fire, then, by an association of ideas, the flame of being. Thor's hammer, identical in form with the Phœnician masculine cross, was the sacred symbol of fire, the hearth, marriage and fertility, and in the god's use of this hammer to restore his two dead goats, the symbol suggests immortality. The paper traced the gathering of various national crosses by the early converts to the catacombs of Rome, where the crux ansata, swastika, tau-cross and modifications of them all, appear on the walls and tombs. The wave of enthusiasm occasioned by the discovery of America brought many missionaries across the Atlantic—following the reports of those who took possession of the soil under the sign of the cross—and they were amazed to find the cross already so prevalent, attributing its presence to some early christian missionary, traditionally St. Thomas. Its use on altars, tablets and pottery, in weaving, in ceremonies, as well as in representing the orientation of the earth and the heavens, the material and the invisible world, were suggested in support of the thesis that whether as swastika, emblem of fire, wind or water, crux ansata emblem of reproduction, the tau-cross suggestive of the masculine function, or the Latin cross with its acquired ethical suggestion, the cross has always been the generic symbol of the impartation and maintenance of life.

John R. Swanton,
Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

The fifty-seventh meeting of the society was held at the Dewey Hotel, November 26, at eight o'clock P.M., Vice-president Spillman presiding. The following papers were read.

Maize and Pellagra: Dr. C. L. Alsberg.

A description of the clinical features of pellagra was presented, its history in Europe sketched and its occurrence in North and South America discussed. The different hypotheses in regard to its etiology were considered, viz., the malnutrition theory, the spoiled maize theory and the work of Lombroso, the mold theory and the work of Ceni, the bacterial theory, and the protozoon theory. It may be said that pellagra occurs where spoiled corn forms the most important feature of the diet of wretchedly poor peasantry, that most investigators believe it to be an intoxication by as yet unidentified toxic products of the growth of lower organisms upon corn, and that this belief has not as yet been established beyond doubt. In the United States sporadic cases have probably existed for many years. Its apparent increase of recent years may, if the spoiled corn theory be correct, be due to climatic and agricultural changes leading to change in varieties of corn grown, to harvesting of more immature corn, and to imperfect curing, all factors which may favor spoiling. The industrialization of the south with the resultant consumption of corn shipped long distances and the disappearance of the small neighborhood grist mill, may be further factors. Deterioration of corn is usually due to its great moisture content, when harvested prematurely or imperfectly cured. The remedy is to cause it to be thoroughly dried, preferably in kilns, before it leaves the farmer. This would not merely be an important hygienic measure but an equally important economic one. The saving of freight charges would be enormous, for many millions of gallons of water in the form of unnecessary moisture are hauled annually from the corn-belt to the seaboard.

The Relation of Plants to Peat Formation: Professor Charles A. Davis.

A short account of two important types of peat deposits and ecological relations of the plants from which they are formed.

The chief agents of decomposition of vegetable

matter are aerobic organisms, principally plants; anaerobic forms being much less active and seemingly wanting in many peat beds. Over most of the United States, peat is formed only where the ground-water level is above or very near the soil surface, because it is only through saturation that the air and the more actively destructive organisms are excluded and vegetable accumulations partially preserved. The numbers and kinds of anaerobic organisms and the decomposition resulting from their activities seem also to be reduced by the presence of gases like hydrogen sulphide and methane and of colloidal and soluble poisonous substances resulting from the decomposition in progress. Most peat beds show a much greater amount of decomposition above the water level than below it.

The two types of peat deposits discussed were those formed (1) in depressions below the ground-water level, ponds and lakes; (2) where the soil surface was at or slightly above the ground-water level, poorly drained flat areas.

In (1) the major part of the material is laid down under water through the growth of aquatic plants. These are primarily governed in the depth to which they can grow below the water surface by the distance to which enough light can penetrate for the minimum requirement to enable them to establish themselves. Few species reach twenty feet even in clear water, and this is reduced by any suspended or dissolved colored matter. Peat formation is slow at maximum depths at which plants grow, and more rapid in shallower water—hence the deposits often take the form of terraces, with steep outer faces. The peat at different depths is chiefly or wholly formed by definite plant associations that arrange themselves zonally around the open water, according to their tolerance of poor light, low temperature and other unfavorable conditions. Free-floating plants of all types may form additions to any part of deposits or make up a large part of any given one.

When the surface of the accumulated débris rises nearly to the level of the water, turf-forming plants may invade it and form a permanent cover. Shrubs, coniferous trees and sphagnum moss may establish themselves when the surface is about a foot above the permanent water level, and the latter may then build up the deposit for a few feet. The sphagnum-covered peat bed is more common at the north than in the south, where shrub and tree-covered deposits are more common.

The plants that form peat beds on flat areas are those able to endure excess of water, and probably toxic substances about their roots. Those found in a particular locality will depend on the permanent relation of the ground-water level to the soil surface, and may be mosses, sedges, grasses, shrubs or trees, or mixtures of all these. If the water level rises as the peat accumulates, as seems often to happen, the same plant associations may form the entire deposit. If the peat builds faster than the water level rises, the significant plants will change until a forest association is developed.

If the water level rises faster than the peat, pond conditions may be developed. In any case, peat beds will be of homogeneous structure only where the water level rises with the peat, and it is only on such deposits that the plant association growing on the surface is significant of the structure and quality of the peat below.

W. W. STOCKBERGER,
Corresponding Secretary

THE TORREY BOTANICAL CLUB

THE meeting of October 27, 1909, was held at the New York Botanical Garden and was called to order at 3:30 P.M. by Dr. E. B. Southwick.

About forty persons were present. After the reading of the minutes of the preceding meeting, the scientific program was presented, the first contribution being made by Mrs. N. L. Britton, who spoke on "Arctic Mosses." The speaker's remarks were based on studies of mosses sent from the American Museum of Natural History to the New York Botanical Garden for determination. They were collected by Commander Robert E. Peary in Grant Land in 1902, and by Dr. L. J. Wolf at Wrangle Bay, Lincoln Bay and Grant Land in 1906. The Peary collection includes 62 bryophytes, of which 57 were mosses, representing 24 genera, and 5 were hepatics.

Specimens of flowering plants were also exhibited which have recently been acquired by the New York Botanical Garden through the courtesy of the Peary Arctic Club from the American Museum of Natural History.

The collection consists of herbarium specimens made on the late expedition of Commander Peary to the North Pole and were collected mostly by Dr. J. W. Goodsell. While some of these were obtained on the northern coast of Labrador, the majority were collected on Grant Land, in the northern portion of Ellesmere Land, an island off the coast of Greenland. One of the packages contained specimens from perhaps the most northern

locality where flowering plants have ever been found, while another is from Etah, the most northern habitation of man.

Since the subject of mosses was the principal topic of the hour, Dr. Murrill referred briefly to the genus *Dictyolus*, the species of which are found on living mosses. This genus belongs to the Chanterleæ, a tribe of gill-fungi, and there are only two species known in North America, *D. muscigenus*, occurring from Greenland to South Carolina, and *D. retirugus*, known from Greenland, Alaska, Minnesota and California. Both species are small and thin, grayish or brownish in color and have folded-like gills. *D. muscigenus* may be recognized by its distinct stipe and dichotomous gills, while *D. retirugus* is sessile or subsessile with branched, reticulate gills.

Dr. N. L. Britton spoke of the three genera of Cactaceæ, *Carnegiea*, *Pachycereus* and *Cephalocereus*, and showed specimens of their flowers. The genus *Carnegiea*, dedicated to Mr. Andrew Carnegie and formerly known as *Cereus giganteus*, consists of a single species. Some of these plants attain a height of sixty feet and branch at from twelve to twenty feet above the ground. The flowers are funnelform with a nearly cylindric tube, bearing a few broad triangular scales. *Pachycereus* blooms at a different season from *Carnegiea* and the perianth tube is clothed with woolly hairs and bristles.

Cephalocereus, which has many representatives in the West Indies and some in Mexico, derives its name from the fact that the top of the plant is hairy. At Key West, Florida, there is a colony of *Cephalocereus keyenses* which is related to some of the Cuban and Bahaman species. It is the only locality where this species is known to exist. As it is growing here on a government reservation, it will most likely be preserved.

Mr. Roland M. Harper told of his experiences in the south from July, 1908, to July, 1909. A few weeks were spent at the Biltmore Forest School, North Carolina. Specimens were observed here of *Helonias bullata* and *Dalibarda repens* which are not listed in Small's "Flora of the southeastern United States." The former was reported several years ago by F. E. Boynton, while the latter was first noticed by Dr. Homer D. House.

Six weeks were spent in Georgia, particularly in the vicinity of Pine Mountains and among the sand-hills of the fall line region, where he found *Chamæcyparis thyoides* which has not previously been reported from the state. Specimens of *Chrysopsis pinifolia*, discovered by Elliott in 1815, and known only from one county, were collected, and also a twining *Bartonia*. Together with a party of geologists, Mr. Harper made a trip of 260 miles on the Warrior and Tombigbee rivers in Alabama, which occupied a period of ten days. Here he collected an *Equisetum* which resembles *E. arvense*, but is several hundred miles out of the range of that species. While in Florida studying peat for the state geological survey, he found several interesting plants, *Spartina Bakeri*, which is very common but not mentioned in any flora, and an arborescent *Serenoa serrulata*, some plants of which attained a height of ten feet, and an undescribed species of *Prunus*. Mr. Harper explored the southern end of the everglades, following about the same route as that taken by Dr. Britton in 1904 and Dr. Small in January of this year.

Dr. Southwick reported the finding of *Viola pedata* in flower, October 25.

The meeting of November 9, 1909, was held at the American Museum of Natural History with Vice-president Barnhart in the chair. Eighty-nine persons were present.

The scientific program of the evening consisted of a talk by Dr. Marshall A. Howe on "Some Floral and Scenic Features of Porto Rico." This was a semi-popular account of some of the more striking features of the native and introduced flora of the island and was illustrated by about a hundred lantern slides, some of which showed, incidentally, many interesting topographic and scenic details of the Porto Rican mountains and sea-coast. Special attention was given to the native palms and their economic uses. The photographs shown included, also, several of the cacti, which are much in evidence in certain places along the southern shore of Porto Rico and on the adjacent island of Culebra. In striking contrast with the xerophytic vegetation of the southern slopes are the mesophytic forests, now, unhappily, of very limited extent, on two or three of the highest mountains. The soil of the island is or has been very nearly all under cultivation, but in addition to the two or three comparatively small forested areas there are, here and there, in various parts of the island, rocky hills where the native vegetation may be found under very nearly natural conditions. The sugar, coffee and tobacco industries were also discussed and illustrated by the speaker.

Percy Wilson,
Secretary